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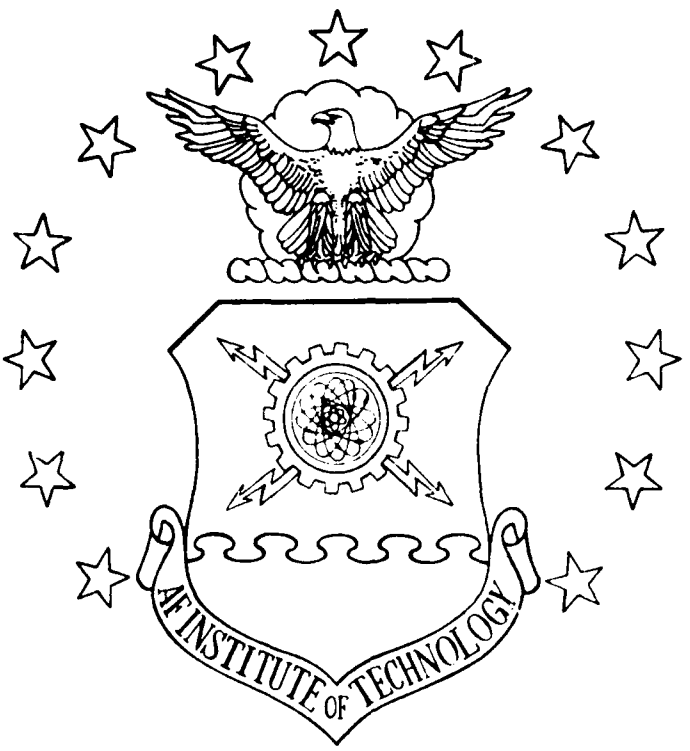

ENHANCING COMPETITION THROUGH THE IMPROVEMENT OF THE DUAL SOURCING DECISION CRITERIA AT THE AERONAUTICAL SYSTEMS DIVISION

THESIS

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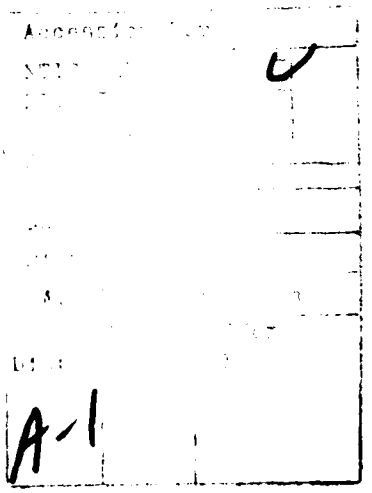

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THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Contracting Management

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Captain, USAF

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It is my hope that you share my feeling of accomplishment.

Edwin F. Little

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Abstract

Dual sourcing is a recognized method of inducing competition into the Department of Defense acquisitions. The environment in which DOD acquisition occurs has changed dramatically in the past five years. Both the executive and legislative branches of government have initiated various programs and laws all proposing to improve the acquisition process. The latest aid comes from Congress via the Competition in Contracting Act of 1984. This act philosophically changed the emphasis of DOD acquisition from the method of contracting to the market condition of "full and open" competition and its promotion and sustainment. This new emphasis has increased the interest in dual sourcing amongst program managers. When past dual sourcing actions are studied, the results do not consistently produce reduced costs and strengthened industrial base. Knowing what criteria best measure dual sourcing's potential to enhance competition allows DOD program managers to more effectively utilize limited resources. This research looked at current literature findings on dual sourcing criteria. These findings were then compared to three case studies and the findings from five interviews. The interviews involved Aeronautical Systems Division program offices currently involved in dual sourcing actions. The research objective was to evaluate the dual sourcing criteria from these three sources and propose optional dual sourcing criteria improving the dual sourcing decision. Six conclusions were reached

with this methodology. From these conclusions two recommendations were made. It was found that the basic criteria in the literature are still valid but many of the criteria are subjective. As such, it is difficult to generate concrete supportable estimates. Secondly, an additional criteria - producer stability was suggested for inclusion in the decision process to split a contract award between two producers.

ENHANCING COMPETITION THROUGH THE IMPROVEMENT OF THE DUAL SOURCING DECISION CRITERIA AT THE AERONAUTICAL SYSTEMS DIVISION

I. The Research Problem

Introduction

Competition's ability to reduce weapon systems procurement costs is not a new concept to the Department of Defense. This concept was advocated in the 32 initiatives pursued in 1981 by then Deputy Secretary of Defense, Frank C. Carlucci in his memorandum entitled, "Improving the Acquisition Process". In a 9 September 1982, Secretary of Defense Memorandum, Mr. Weinberger stated the following.

> Must give greater attention to obtaining competition in the placement of contracts by all DOD components. The benefits of competition are well known. Competition serves to reduce costs, improve quality, and enhance the industrial base [51:1].

In 1984, Congress passed public law 98-369, The Competition in Contracting Act. This act mandated the use of competition in the awarding of federal contracts (50:11). Competition's importance in controlling weapon systems costs is the stated policy of the Air Force Systems Command (AFSC) Commander, General Skantze (17:50). A method of stimulating competition in the market place is dual sourcing (48:13).

Dual sourcing is narrowly defined as the splitting of a weapons production buy between two competitors, with the

largest portion of the buy going to the lowest proposal. Similar terminology for dual sourcing is second sourcing and competitive split buy. Dual sourcing requires the presence of at least a second qualified source or the government action involved in establishing the second or alternate source (4:3). Additional requirements or conditions necessary for the government to establish a second source are: (1) adequate technical data, (2) sufficient production lead time, (3) availability of government technical and material assistance, (4) sufficient production quantity, (5) up front funding to establish the second source and (6) an appropriate economic climate.

Environmental Pressures Favoring Competition

An understanding of the economic concept called competition is essential to comprehending the DOD acquisition environment. Richard Leftwich in his book, The Price System and Resource Allocation, sees competition as being a perfect or pure market structure. The market qualities of pure competition are homogeneity of the product, smallness of each buyer or seller relative to the market, mobility, and absense of artificial restraints. Perfect competition adds the constraint that each economic unit possess complete knowledge of the economy (22:29-30). DOD defines competition as "a condition of the market place resulting from two or more economic entities each vying to sell for limited goods or services on the basis of price or other factor (48:65)."

AFSC's advocate for competition, Mr. Anthony DeLuca, defines competition as, "simply when you have two guys going head to head to satisfy your request" (12:17), be the procurement a sealed bidding or a competitive proposal. He goes on to note the monopsonistic nature of the Defense Department and the monopolistic nature of many of our suppliers. Because of this, Mr. DeLuca states we must often create a competitive environment where none presently existed (12: 17).

The DOD weapon systems acquisition process has received a lot of assistance from Congress. Not until 1947, with the passage of the Armed Services Procurement Act was the DOD contracting process consolidated. This act provided a complete collection of contracting guidance for the contracting community. It established competition in the form of the required formal advertising as the primary method of contracting (48:22). In 1969 the acquisition process as outlined in the Armed Services Procurement Act was found to be inflexible by a Blue Ribbon Defense Panel. As a result, David Packard, Deputy Secretary of Defense authored several changes which permanantly altered the acquisition process. He established the Defense System Acquisition Review Council (DSARC) process and applied the principle of decentralized decision making and centralized control to system acquisition. Growing out of Mr. Packard's work was the Office of Management and Budget's A-109 circular on acquisition policy. This circular emphasized the maximum use of compe-

tition and innovation. In 1981, Deputy Secretary of Defense Carlucci signed into being his 31 initiatives to revitalize the defense acquisition process. He called the program the Acquisition Improvement Program. On 27 July 1982, he issued initiative number 32 entitled, "Encouraging Competition" (48:28). These 32 initiatives have become the basis of today's acquisition policy.

More recently, the Department of Defense, General Services Administration (GSA) and National Aeronautics and Space Administration (NASA) jointly issued the Federal Acquisition Regulation (FAR) on 1 April 1984 replacing the Defense Acquisition Regulation. Part 7 of Volume 1 addresses acquisition planning and competition. The subparagraph on competition requires that the weapon systems acquisition plan contain the following consideration:

> Describe how competition will be sought, promoted and sustained throughout the course of the acquisition. If noncompetitive contracting is being recommended, identify the source and discuss why competition can not be used [14:7-2].

Congress followed suit and passed Public Law 98-369, Competition in Contracting Act of 1984. Effective 31 March 1985, each government agency must appoint an advocate for competition. Also, the new law "significantly altered" statutes governing government contracting in an effort to increase the use of competition in government contracts (36: 216). Most recently, Congress, in Public Law 99-145, FY86 Defense Authorization Bill, requires the presence of multiple sources for systems and major subsystems initiated

after FY 1986 (36:204).

The Major Weapon System Acquisition Cycle

To understand competition in the DOD environment requires a knowledge of the Department of Defense weapon system procurement process or major weapon system acquisition cycle. DOD Directive 5000.1, "Major System Acquisition", March 29, 1982, states general acquisition policy and acquisition management principles and objectives for the acquisition of major weapon systems. The regulation states in paragraph 2a, "Effective design and price competition for defense systems shall be obtained to the maximum extent practicable to ensure that defense systems are cost-effective and are responsive to mission needs (15:4)." The procedures section of DOD 5000.1 identifies the four phases of weapons acquisition as (1) concept exploration, (2) demonstration and validation, (3) full-scale development, and (4) production and deployment. The regulation identifies milestone decision points before each phase can proceed. The Secretary of Defense must direct the services to proceed with each phase of the cycle except the production and deployment phase. This decision has been delegated to the service secretaries barring no major changes to the program. A brief description of each acquisition phase follows. (Figure 1)

Concept Exploration Phase. This phase is concerned with identifying alternative solutions to the stated mission problem. The program manager begins to develop an acquisition strategy during this phase (24:14). "Even at

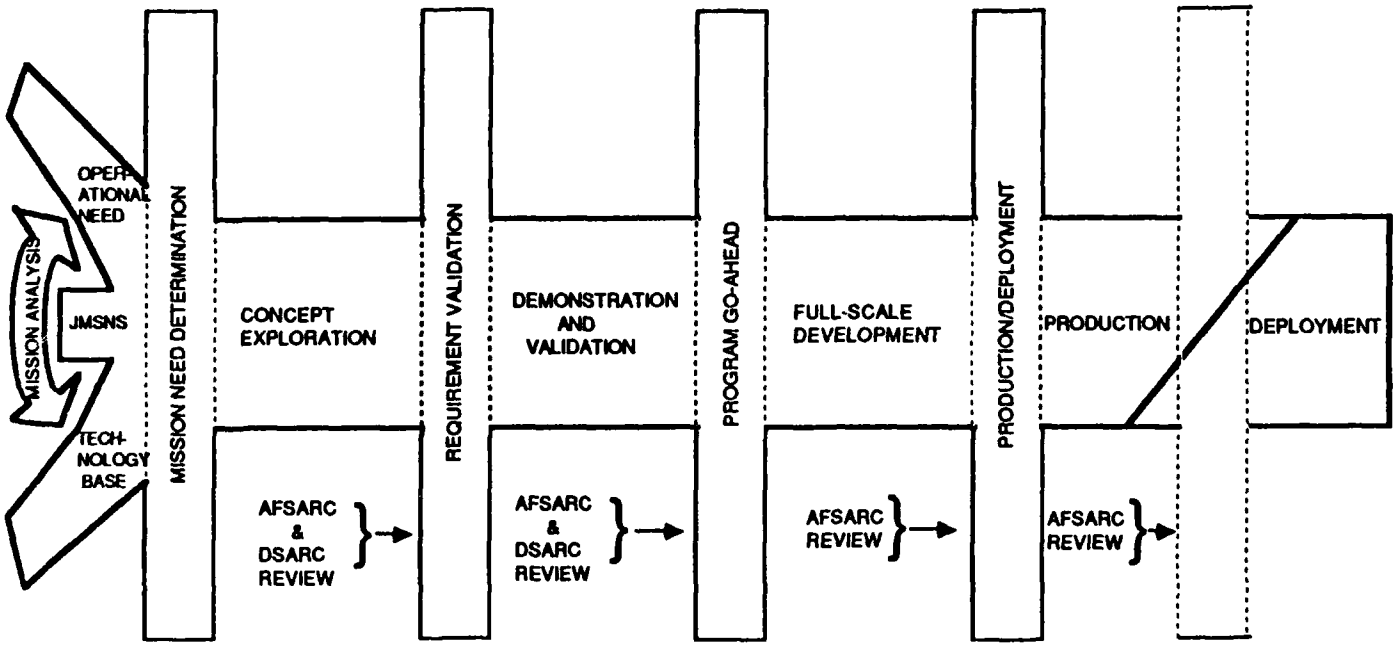

Fig. 1. MAJOR SYSTEM ACQUISITION LIFE CYCLE
(24:6A)

this early stage cost estimates must be made for each concept." This is a competitive exploration with the goal to select alternative solutions to carry into the demonstration and validation phase (24:16,17).

Demonstration and Validation Phase. This phase demonstrates the alternative solutions through paper studies, prototypes, etc.; seeking to reduce technical risk and economic uncertainty. The demonstration/validation phase culminates in the selection of the most practical solution to the problem. Considerations in this decision are technical risk, program resources, tradeoffs and availability of competition (24:22,23).

Full-Scale Development Phase. The primary thrust of this phase is the existance of a pre-production prototype and the documentation necessary to produce and field the unit. This phase includes testing, both operational and engineering (24:26-28).

The Production and Deployment Phase. This phase includes the production of the weapon system, training equipment, spares, facilities, and any other necessary items critical to field deployment (24:30).

Dual Sourcing Techniques

Establishing a qualified second source involves the application of numerous contracting techniques such as leader-follower, technical data package, leader-leader, licensing, and contractor teaming.

Leader-follower. The leader-follower technique

involves a requirement that a sole source provide the know-how and technical assistance necessary to qualify a second producer thus allowing it to become an alternate source of supply (53:41).

Technical data package. This technique is very similar to the leader-follower technique. A technical data package (TDP) is a technical description of an item adequate enough for another qualified producer to duplicate the work. The TDP is expected to be properly validated and of sufficient detail to stand along (53:24,26,34).

Leader-leader. Two contractors split the production phase of a major weapon system buy, instead of one producer leading the way and the introduction of a second producer following (44:282).

Licensing. Likewise, this technique is very similar to leader-follower. A contractor provides technical data and assistance to another company, assisting it in becoming an additional producer of a product. A licensing agreement means the original producer is selling or renting the production rights to the second company (53:52).

Contractor teaming. Teams of contractors are often formed which then compete against each other. The teams make contract proposals and the government chooses the best offer (53:61,62). By choosing the best offer the government is choosing a team or dual source.

These five examples represent the basic techniques used to establish a second source. There are many other techniques

TABLE 1

DUAL SOURCING TECHNIQUES AND THE WEAPONS SYSTEM ACQUISITION PHASE

DUAL SOURCE TECHNIQUE	CONCEPT EXPLORATION	DEMONSTRATION AND VALIDAITON	FULL-SCALE DEVELOPMENT	PRODUCTION	REPRO-CUREMENT
TECH DATA PACKAGE				SOLE SOURCE PRODUCER	DUAL SOURCE PRODUCERS
LEADER/ FOLLOW ER				SOLE SOURCE PRODUCER	DUAL SOURCE PRODUCERS
LICENS ING				SOLE SOURCE PRODUCER	DUAL SOURCE PRODUCERS
LEADER/ LEADER	PAPER COMPETITION	HARDWARE COMPETITION		DUAL SOURCE PRODUCERS	
CONTRAC TOR TEAMING	PAPER COMPETITION	HARDWARE COMPETITION		DUAL SOURCING BY TEAM MEMBERS	

referenced in the literature which combine the characteristics of the basic five in varying proportions or simply use different terminology for the same concept.

Dual Sourcing and the Acquisition Cycle

Dual sourcing can begin at any of the four major weapon system acquisition phases (Table 1). Anytime two contractors are performing the same task on the same weapon system/component, dual sourcing is occuring. Dual sourcing stresses price and/or design competition (46:20). Acquisition competition beginning at the concept exploration phase or demonstration/validation phase often ends in a prototype competition and the selection of a sole source contractor going foreward into the full-scale development and production phases. Examples of this acquisition strategy are the M-1 tank and AH-65 Attack Helicopter. Competition by means of dual sourcing can begin as early as the concept/exploration phase of the acquisitiion cycle and be maintained through the production/deployment phase. By far the most common examples of dual sourcing occur during the reprocurement phase of the acquisition of additional weapon systems after initial deployment. Some examples are the Sparrow Aim-7F missile (guidance and control), Sidewinder Aim-9 missiles (guidance and control), GAU-8 ammunition, and the cruise misssile engine (29:32,38,40,44).

Department of Defense Competitive Procurement Efforts

The emphasis on competition has not gone unheeded in the DOD. The Air Force had awarded 39.2% of the FY85 pro-

curement budget in a competitive environment by 30 September 1985, exceeding the Air Force goal by six percent. This performance is an eight percent increase over FY84. In terms of procurement actions the 39.2% figure was 82.2% of all the procurement actions in the Air Force (Figure 2) (32:6,8).

An ultimate level of 40% to 45% of procurement dollars competitively awarded is seen as the realistic maximum by the Air Force (44:282). When viewed from a perspective of major weapon systems, the Air Force plans to dual source extensively in FY87. President Reagan's 1987 defense budget proposes to dual source the MX missile (Martin Marietta Corporation, Boeing Company, and Northrop Corporation), and to continue dual sourcing actions in the cruise missile (General Dynamics, Boeing, others), AMRAAM (Hughes, Raytheon Company), and the jet engines for the F-16 (General Electric Co. and Pratt and Whitney) (7:8). Brigadier General Gerald C. Schwankl, the Air Force Competition Advocate General has targeted subcontractor competition as well as competition at the prime contractor level. He stated his goals in this area at the 5 December 1985 Air Force Competition Advocate Conference. Brigadier General Schwankl has set as a goal and management challenge the increasing of subcontractor competition (32: 11,13).

The Air Force and DOD are committed to dual sourcing as a means of inducing competition. But, when past performance of dual sourcing efforts are investigated, conclusive support for the dual sourcing - reduced price acquisition phenomenon

PERCENTAGE OF CONTRACT ACTIONS AWARDED COMPETITIVELY

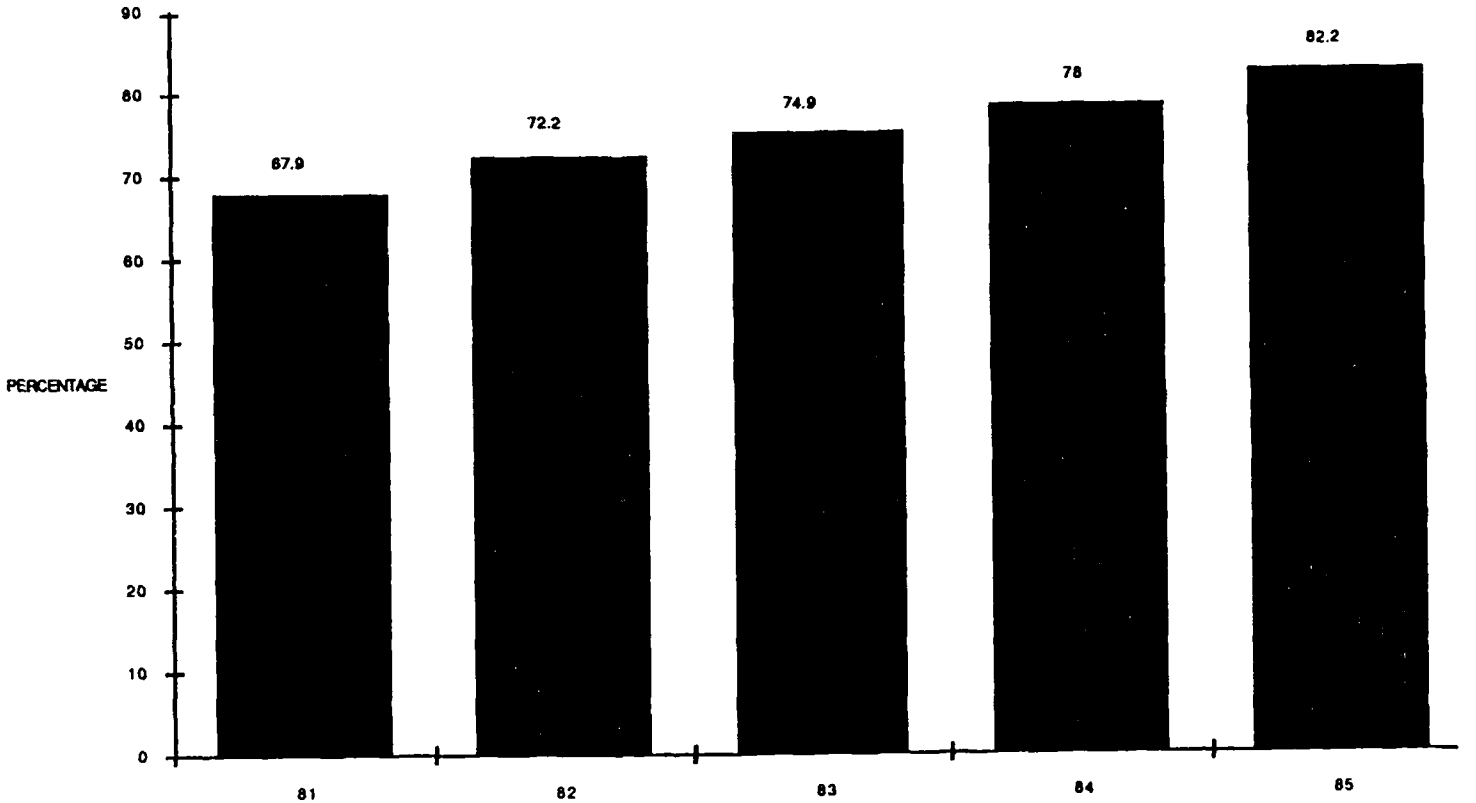

Fig. 2. AIR FORCE COMPETITION PERFORMANCE (32.8)

does not exist. Mr. Beltramo, founder of Beltramo and Associates, a consultant firm on economic analysis in the international aerospace market, has studied the dual source - reduced price linkage and found the data to be insubstantial. Only 3 of the 7 competitive split buys yielded a savings. In a 1984 report, the United States Government Accounting Office found "dual sourcing was not employed solely or primarily for the purpose of price competition (50:5)." The reasons most often cited to dual source major weapon system production efforts were (1) improvement of the industrial mobilization base or (2) establishment of an adequate production capacity to support delivery requirements. Price competition was a secondary objective in 7 of the 55 Army, Navy, and Air Force procured items studied (50:5).

Problem Statement

Mr. Beltramo, in an unpublished paper, "A Broader Orientation for Weapon Systems Acquisition Policymaking," stresses the need to look at the long term effects of acquisition policy decisions. One such decision is dual sourcing a major weapon system. Dual source decisions intended to reduce acquisition costs and/or strengthen the defense industrial base inconsistently achieve either of the intended goals (3:8). With the passage of the Competition in Contracting Act (CICA), weapon systems project managers are expected to compete all acquisition actions. To do so demands improved, more accurate decision criteria on which to base the dual source decision. The documented failure to consistently predict dual

sourcing outcomes reflects the use of an ineffective decision process. Program managers need a revitalized dual source decision process using decision criteria which accurately forecasts the long term effects pf dual source decisions. With these revised decision criteria, program managers can more effectively commit scarce program dollars to achieve maximum mission accomplishment. In doing so, program managers must recognize competition is the law in todays' acquisition environment. The more accurate by the long term effects of competition (specifically dual sourcing) can be forecasted the more effectively DOD can utilize scarce program assets.

Research Objective

The research objective will evaluate current dual sourcing criteria documented in dual sourcing literature and policy directives. Secondly, the criteria on which three past dual sourcing decisions were made in Aeronautical Systems Division (ASD) will be analyzed and finally, ASD contracting officers will be interviewed. Based on the resultant information from the three sources, optional dual sourcing decision criteria will be proposed for use by program managers. These optional decision criteria will be designed to form the foundation for improving dual sourcing decisions. Thereby, ASD program managers will be able to utilize their scarce program assets more effectively.

Investigative Questions

The seven investigative questions this research will answer are listed below. The three previous dual sourcing decisions and interview responses will be analyzed based on these seven investigative questions.

1. Is a logical decision process followed during planning for production competition of a major weapon system?
   a. If so, what are the decision criteria and how is dual sourcing considered in this process?
   b. If not, how is planning for production competition done?

2. How does the decision process determine when to introduce a second source into the acquisition cycle?
   a. Into what stage of the acquisition cycle is it introduced?

3. Because of the current emphasis on competition and dual sourcing in the acquisition environment, how is the ultimate dual sourcing decision in the best interest of the government? Where are the government's best interests not met?

4. What were the expected results of past dual sourcing decisions?

5. Were these expectations met? To what degree were they satisfied/not satisfied?

6. Is the dual sourcing decision so dependent upon the product in question that a common decision rule for all major weapon systems becomes impractical?
   a. What characteristic(s) of the product enhances/ inhibits the use of the decision rule?

7. What influence has dual sourcing had on enhancing competition?

Scope of Research

The literature review will provide the reader a historical view of dual sourcing but will focus on specific dual sourcing requirements and the resultant advantages/ disadvantages. Three previous dual sourcing examples, GAU-8 ammunition, alternate fighter engine and cruise missile acquisitions will also be discussed. These three examples represent weapon systems ranging from relatively simple technology of ammunition to the technologically complex alternate fighter engine and cruise missile. This research effort will limit the sample population at ASD to those principal

Contracting Officers (PCO's) who have participated in dual source contractual actions. This population is easily accessible through the ASD contracting directorate. This research effort will collect data on the latter two sources using the attached interview guide (Appendix 1).

Analysis

The data collected from the GAU-8 ammunition, alternate fighter engine and cruise missile acquisitions in addition to the interviews will be edited for accuracy and rearranged into more meaningful groupings to facilitate interpretation of results. Editing of the data is mainly concerned with insuring accurate data has been collected. The data will be grouped into data categories representing similar responses. Key data categories necessary in supporting optional decision criteria are (1) Reason for dual sourcing a weapons system, (2) Criteria used in dual sourcing decision, (3) Competition decision process, (4) Expected results of dual sourcing, (5) Results of dual sourcing decisions, (6) Extent of decision formalization, (7) Weapon system characteristics inhibiting/enhancing the formalization of the decision process. Analysis of the data will involve the interpretation, comparison and contrasting of data groups one through seven. Comparison and contrasting of data groups one through five will provide the support for determining those criteria which most consistently predict a dual sourcing outcome. Comparison and contrasting

of data groups six and seven, will provide the support for limiting factors affecting the decision criteria. The analysis of data groups one through seven will result in the identification of improved dual sourcing criteria which program managers can use to enhance long-term procurement cost reduction and competition.

Conclusion

This analysis will be the base for optional dual sourcing decision criteria. These optional criteria will support improved dual sourcing decisions in the Aeronautical Systems Division.

II. Literature Review

Introduction

The literature review is divided into two major sections and is designed to broaden the reader's background in dual sourcing. First, the dual sourcing environment is examined in greater detail. It discusses the procurement conditions conducive to the dual sourcing techniques in chapter one and how these conditions interact with each other. The key point made is the decision complexity. The second section discusses the history of competition and the use of dual sourcing. The content of the key initiatives mentioned in chapter one is discussed along with examples of dual sourcing from WWII and other landmark periods. The second section also notes the vacillating interest expressed the Department of Defense and the US Congress in the military procurement process. Procurement reform initiatives from both sectors have intensified over the last ten years. Together, the two sections portray a complex environment in which to operate and execute an abundance of regulatory directives.

The Dual Sourcing Environment

Preconditions of Dual Sourcing. A successful dual sourcing action by a program office entails the presence of numerous preconditions. These conditions require extensive government and contractor pre-planning. Commonly listed conditions conducive to dual sourcing are (1) adequate technical data, (2) sufficient production lead time, (3) availability of government technical assistance, (4) sufficient production quantity, (5) up-front funding to establish the second source and (6) an appropriate economic climate (53: 106-108,20:349). A dual sourcing decision requires the consideration of many other issues. Table 2 lists some of the issues considered in past dual sourcing decisions. This list is not exhaustive, but demonstrates the complexity involved in the decision to dual source a major weapon system and its components. The ensuing paragraphs highlight some of the critical subfactors within each of the dual sourcing conditions.

Dual sourcing by the government requires the presence of a defense industrial base capable of supporting such an action. The defense industrial base encompasses all of the existing manufacturing resources supporting the military's readiness needs. Dual sourcing requires the presence, in the market place, of an alternate producer capable of being established as an efficient second manufacturing source. It is the program office, through a credible market research, that documents the current state of the industry. Often

TABLE 2

ISSUES IMPACTING DUAL SOURCING

Presence of Defense Industrial Base
- Market Research
- Lead Time Notification
- Industry Capacity

Assessing Technological Risk
- Level of Technology Employed
- Complexity of Hardware
- Design Stability
- Producibility

Transfer of Production Technology
- Adequacy of TDP
- Data Rights
- Contractor Investment
- Learning Curve
- Technical Assistance need by second source

Maintenance and Supportability
- Spare Parts
- Training

Upfront funding for Nonrecurring Costs

Economic Long Run Production Rate

there are not enough, qualified producers to dual source a major weapon system or its major subcomponents. General Lawrence A. Skantze, Commander Air Force Systems Command, has stated that "competition is not always feasible"; "sham competitions are worse than wastes of time." "They're wastes of money (34:7)." The defense contractors in the market place need lead time with respect to future competitive efforts. This necessitates that a market research study "actively engage industry for planning purposes--not just assessing what exists on the surface (34:8)." If the government is contemplating the establishment of a new production source; a credible market survey is essential in assessing the cost trade-off (34:10).

A closely related defense industrial issue is underutilized and unutilized capacity. Empirical work done at the Naval Post Graduate School documents the effect of industry capacity utilization on dual sourcing and price reduction. After studying the dual sourcing actions in six missile weapon systems, the researchers found dual sourcing was to out advantage when industry capacity utilization averaged less than 80%. The application of dual sourcing when the industry capacity averaged greater than 80% was generally found to be inadvisable (18:VII). These findings suggest an optimum industry capacity range favorable to dual sourcing. Even with this empirical evidence, inadequate factory (industry) capacity may force the government to second source, in order to boost the industrial

base capacity. The government makes the decision knowing the acquisition costs will increase.

Assessing the technological risk of a proposed weapon system to the government directly impacts the dual source decision process. Technological risk involves the determination of the level of technology, complexity of the hardware, design stability, and their impact on producibility. The level of technology employed; "state-of-the-art" versus "off-the-shelf" significantly effects dual sourcing potential. The closer the weapon system approaches "state-of-the-art" technology, the more difficult dual sourcing becomes. The level of technology complicates the interface between the production sources, regardless of the dual sourcing arrangement. Complexity of hardware and design stability are heavily influenced by the technology level. Highly complex systems require close coordination between the producers, making the project less desirable to dual source (33:53,54). A proposed weapon system pushing "state-of-the-art" technology consisting of many complicated interfaces promises to introduce extreme instability into the weapon design process. The stability of the weapon design process determines the quality of the Technical Data Package (TDP). Stability implies the completion of the development process and minimization of engineering/production changes. An excellent TDP based on a stable design configuration forms the foundation for producibility success.

Producibility is defined as follows:

> The relative ease of producing an item or system. This is governed by the characteristics and features of design that enable economical fabrication, assembly, inspection, and testing using available production techniques [16:2.1].

Producibility issues in dual sourcing are concerned with specialized production processes, equipment and facilities, and the technical resources needed to transfer the entire production process to a second source. A specialized production process inhibits the establishment of a second production source because, modern weapon systems require specialized production processes to meet the exacting tolerance specifications (49:4). Second sourcing actions are aided when common production processes exist between the current and future production sources. Otherwise, production technology transfer becomes increasingly complicated with the incremental introduction of company specific production processes. To establish a second source requires the transfer of technology processes previously mentioned plus the transfer of the associated specialized tooling, facilities configuration and work force capable of executing the process. The cost of tooling and facilities for a second source increases with the requirement for specialized production processes; potential second sources decrease and the non-recurring costs of production start-ups increase with specialization (33:55). The greater the production specialization, the greater the technology transfer task to the second production source. As a result, recovering the

initial (non-recurring) costs of establishing a second source becomes difficult.

Implementing dual sourcing and transferring the production technology to the second producer requires detailed planning. This planning should examine (1) the adequacy of the TDP, (2) data rights, (3) contractor research and development investment, (4) the production learning curve, and (5) degree of technical assistance required. The basis for a good TDP was discussed in a prior paragraph (page 8). The need for a good TDP can not be overemphasized. The product received by the government will reflect the quality of the specifications in the TDP. The government must consider ownership of data rights in obtaining an unrestricted TDP. It is difficult, if not impossible, to second source a weapon system if data rights are controlled by the original source. If the government does not own the data rights, then they must be purchased from the sole source. Negotiations for data rights can prove to be time consuming and very expensive. Expensive to the point of making a dual source action unrealistic (49:4,5). Unrealistic, because the second source must then produce the product from a form, fit, function prospective. Today, inclusion of data rights transfer to the government at the program's inception is often the price of competing in weapon system buys. A confounding issue with respect to data rights ownership is the weapon system's applicability to commercial ventures. A high degree of transferability to the commercial world could in-

voke the owner of the data to demand protection of "trade secrets." Likewise, a high degree of transferability to commercial work (when the government owns the data rights) could increase the interest of potential second sources (33:54). The greater the privately funded R & D the higher the cost to the government for the data rights. "The greater the degree of privately funded R & D on which the design is based, the more reluctant the developer will be to release his design to a second source (33:54)." Paramount to a successful dual sourcing effort is the TDP. The programming office's failure to acquire the TDP or failure to acquire a good TDP significantly enhances/hinders the technology transfer to the second producer. Problems with the TDP could easily cancel any potential savings of dual sourcing.

The learning curve concept in production relates the number of units produced to production efficiency. A steep learning curve infers that after a certain quantity is produced, the original producer becomes very efficient. After this point, it would be difficult to bring "on-line" a second source capable of competing with the original source. With a flatter learning curve, i.e. produce many units before production efficiency is maximized, a second source can be brought "on-line" further on in the production phase of acquisition and still effectively compete with the original producer (33:53).

The actual transfer of production expertise involves

people. Even with a good TDP, people are needed to augment the start up of a second source. The degree and type of assistance depends on the technique of dual sourcing utilized, (1) government engineering aid (TDP), (2) original producer's engineering (leader-follower, licensing), or (3) joint engineering cooperation between the two companies (leader-leader, teaming). Availability/nonavailability and the cost of the human resource need to be considered in the dual sourcing decision.

Maintenance and the concepts of supportability and maintainability become major concerns when a second source begins production. If a system produced by two different companies is introduced into the inventory, the maintenance system is complicated (33:55). The variety of spare parts increases, training increases, and test equipment requirements may increase. These increases require more management attention by the government.

Establishing the second production source or carrying through the acquisition cycle to production and deployment with two sources requires substantial amounts of money for non-recurring costs. The recovery of these costs through competition takes years. Examples of non-recurring costs are the cost to transfer production technology to the second producer and the additional costs of managing two producers, both in-house, and double contractor overhead.

Amortization of the non-recurring costs of dual sourcing over a large, consistant production rate benefits the

potential to dual source a weapon system. What is the best, most consistant yet economical production rate? Determination of this production rate for two or more sources at which a weapon's unit cost decreases is difficult. Capacity utilization of the producer, rate of procurement, duration of procurement, and other products the plant is producing all come into play. Willis Greer and Shin S. Liao in Cost Analysis For Dual Source Weapon Procurement note the critical nature of production rate determination in their work. "Empirical studies in recent years have documented cases where increases in production rate have been associated with increases, decreases, and no change in the unit production costs of weapon systems (18:2.3)." The general rule exposed in the current literature suggests the ideal situation for dual sourcing involves large quantities to be purchased over a number of years (33:52,53.29:2).

The key to successful competition in the market place is planning. The commander of the Air Force Contract Management Division, Major General Weiss stressed the need for acquisition strategies that (1) incorporate flexible requirements, (2) fund dual source development and (3) demand up-front contractor commitment to increasing competition amongst their subcontractors. He further stressed the need to require contractors to develop "long-range competition enhancement plans" as part of the production proposal (52: 8,9). General Skantze, at the same meeting, expressed the criticality of planning in market research by saying:

> We need to get the word out "lead time away" for competition to have positive results ... actively engaging industry for planning purposes ... (43:8)

Advantages/Disadvantages of Dual Sourcing. The advantages of dual sourcing are documented in numerous literature sources. Dual sourcing literature most often cites the following four advantages:

(a) cost savings
(b) maintenance/improvement of industrial mobilization base
(c) improvement of product performance and quality
(d) meeting delivery schedule

The four major advantages to dual sourcing a weapon system or components thereof encompasses several subadvantages. Price competition occurs at the initial release of a dual source or follow-on contract and also each time the contract is recompeted. In this case, awarding a larger share of the planned buy to the lower proposal acts as an incentive for price competition (50:VI). History shows that an indication to the solo source producer that the government may seek to dual source a weapon system may cause the sole source to offer a reduced price (50:9). The predominant afvantage of maintaining/improving the industrial mobilization base is the enhancement of the surge capacity in defense industries. Specifically, developing and maintaining a dual source or splitting production to maintain an additional production line gives the US added production capability to meet the immediate needs of a war or military crisis. Literature notes other advantages of dual sourcing; such as broadening production base in advanced technology

and spreading out the supply/demand fluctuation on a broader industrial base (26:22,23). The bottom line advantage of dual sourcing with respect to the industrial base is -- a broad industrial base able to meet the wartime surge.

The competitive pressures of dual sourcing produce a better product. DOD has used competition to improve technical performance and quality on numerous occasions. The prototype competitions of the 1970's are an excellent example. Dual sourcing extends this technical and quality competition from the demonstration and validation phase to production and follow-on procurement phases of the acquisition cycle.

Dual sourcing enhances the potential to meet the required delivery schedule. Meeting a delivery schedule encompasses the desire to overcome risks associated with production; risks that might be effected by the introduction of a second source are (1) technical, (2) management, (3) labor instability, and (4) plant and capital equipment destruction (4:95,96).

There are four disadvantages to dual sourcing commonly mentioned in dual sourcing literature. The four disadvantages are as follows:

(a) non-recurring costs of establishing a second source.
(b) supportability costs of two systems.
(c) uneconomical production lots.
(d) reduced competition in the market place.

The non-recurring costs of establishing a competitive

second source can be difficult to estimate. Dual sourcing up front costs may increase total costs if the sole reason for implementation is price competition (50:V). These up front cost factors include production technology transfer and inhouse contract administration costs to name two. These costs are short term expenditures while the government's return on an investment is long term and uncertain. Supportability costs concerned with (explicit and implicit) increase in costs involved in maintaining a weapon system produced by two sources. Unless the product of the second source is identical to the sole source product, enough differences exist between the two to require additional spare parts support. If the two units are slightly different, then maintenance training needs expansion. Duplicate support equipment for a dual source procurement may be needed. Inhouse costs to manage and oversee the logistical concerns also increase. The third disadvantage, uneconomical production lots becomes a real concern when the quantity to be procured is split between two producers. Less than economical production lots decreases the number of units produced over which fix costs are allocated, thus increasing individual unit costs. An interesting and seldom considered disadvantage is dual sourcing's potential to drive off current and potential producers, thereby depleting the defense industrial base. Dual sourcing occurs in a competitive environment. If too competitive, the price becomes too low to cover the producer's costs plus an expected

profit. With no potential to make a profit, the producer has no incentive to compete (18:2.32,2.33).

History of Competition and Dual Sourcing

Congress first became interested in stimulating competition in Department of Defense (DOD) contracts in 1809. Congress mandated the advertising of all DOD contracts (48: 22). The first dual sourcing action by DOD was in World War I. The government established Chandler-Groves to compete with Stromberg-Carlson in the development of a floatless carburator. The shock of a second source compelled Stromberg-Carlson to produce the pressure carburator used on all US high powered engines. During World War II, alternate sources were established as supplements to existing production capabilities (4:4). The B-24 bomber had five production sources, the B-29 bomber had four production sources and the B-17 had three production sources. The supplementing of production capability remained the major reason to dual source throughout the Korean Conflict. The B-47 bomber had three production sources (46:14).

The Armed Services Procurement Act of 1947 was based upon the DOD contracting experience of WWI and WWII. It created the Armed Services Procurement Regulations (the precursor to DAR and FAR) and continued the emphasis on an advertising approach to procurement competition. Congressional interest in DOD acquisition policy waned in the 1950's (48:22)

The 1960's marked a renewed interest in DOD contracting by Congress and DOD itself. It was during this decade, that dual sourcing was first defined in the literature (4:5). The sixty's saw the advent of the Planning Program and Budgeting System (PPBS) under the direction of then Secretary of Defense, Robert S. McNamara. He commissioned the 1969 Blue Ribbon Defense Systems Acquisition Review Council (DSARC). The interest, then as is today, of the DSARC is to provide a structured framework to acquire and manage weapons' acquisition in DOD (48:25). Acquisition decisions became increasingly centralized under the policies established by Secretary McNamara. The Navy executed a notable dual sourcing effort in the early 1960's. They dual sourced the Sidewinder missile. During the seven years of production, the Navy reduced the unit cost of each missile to one-seventh of the original purchase price. Weapon systems' complexity increased and volume fell off in the late sixty's; resulting in a decline of dual sourcing initiatives (46:14).

In the early 1970's, then Secretary of Defense Packard reversed the DOD acquisition policy. He changed the centralized management of the McNamara era to a policy emphasizing decentralized decision making and flexibility. The interest of the US Congress in DOD acquisition increased in the early 1970's. They initiated a commission on government procurement in 1969, which for four years, studied, in depth the DOD acquisition process. They recommended (1) more

flexibility in DOD acquisition, (2) favored an increase in multi-year procurements and the establishment of an office of federal procurement (48:25). OMB Circular A-109, Major System Acquisition, set a new course for acquisition policy (Table 3). Design competition is stressed throughout Circular A-109 (Item a above). It expressly forbids "single system design" development of a weapon system except in justified emergencies or where physically and financially impractical (28:10). These very principals of acquisition management were incorporated into DOD Directive 5000.1, Major System Acquisition, and DOD Directive 5000.2, Major System Acquisition Procedures. As a result, the procurement actions of the seventies were predominantly design competition efforts.

The DOD acquisition process has received close scrutiny from the US Congress, the Executive Branch and DOD civilian management. The first acquisition policy action of the 1980's was the Defense Acquisition Improvement Program (AIP). The Deputy Secretary of Defense, Frank C. Carlucci authored 32 initiatives called the Acquisition Improvement Plan in 1981 (Table 4). The AIP goal was to increase the efficiency of the DOD weapons acquisition process. The first 31 initiatives sought improvement in (1) the decision making process (centralized policy, decentralized execution), (2) capital investment and productivity, (3) overhead cost of bureaucracy, (4) planning and execution, and (5) defense readiness. Initiative 32 sought improvement in competition for

TABLE 3

COMPETITION AND OMB CIRCULAR A-109 (28:D3&4)

a) Express needs and program objectives in mission terms not equipment terms to encourage innovation and competition...

b) Place emphasis on the initial activities of the system acquisition process to allow competitive exploration of alternative system design concepts in response to mission needs.

c) Communicate with Congress early in the system acquisition process.

d) Establish clear lines of authority, responsibility, and accountability for management of major systems acquisition programs.

e) Designate a focal point responsible for integrating and unifying the system acquisition management process and monitoring policy implementation.

f) Rely on private industry in accordance with policy.

TABLE 4

DEFENSE ACQUISITION IMPROVEMENT PROGRAM INITIATIVE

*	1:	Acquisition Management Principles
*	2:	Pre-planned Product Improvement
*	3:	Multi-year Procurement
*	4:	Program Stability
	5:	Capital Investment
*	6:	Budget to Most Likely Cost
*	7:	Economic Rates
	8:	Appropriate Contract Type
	9:	System Support and Readiness
	10:	Reduced Administrative Costs
*	11:	Technological Risk Funding
*	12:	Test Hardware Funding
	13:	Acquisition Legislation
	14:	Reduced Number of DOD Directives and Eliminate Non-Cost-Effective Contract Requirements
	15:	Funding Flexibility
*	16:	Contractor Incentives for Reliability and Support
	17:	Decreased DSARC Data
	18:	Budgeting for Inflation
*	19:	Forecasting the Business Base
	20:	Improved Source Selection Process
*	21:	Standardization of Operational and Support Systems
	22:	Design to Cost Contract Incentives
	23:	Implementation of the AIP
	24:	Decision Milestones
	25:	Mission Element Needs Statement
	26:	DSARC Membership
	27:	Acquisition Executive
	28:	DSARC System Criteria
	29:	DSARC/PPBS Integration
	30:	Program Manager Control Over Logistics and Support Funds
	31:	Improved Reliability and Support
*	32:	Encouraging Competition

DOD purchases (48:28,29). While the first 31 initiatives failed to specifically mention competition or dual sourcing, a number of these issues are related to competition and dual sourcing. For example, initiative one involves, improving planning, achieving more economical production rates, and strengthening the industrial base; all related to dual sourcing in varying degrees. Initiative three, multi-year procurement stresses the need for economical lot buys, again a consideration in the dual source decision. The asterik in Table 4 notes those initiatives addressing issues impacting the dual source decision of a major weapon system. After two years, nine issues were outstanding in the yearly status report on initiative 32. In particular, issue two directs the services and the Defense Logistics Agency to appoint advocates for competition, plan for competition, and publicize significant events. Actions recommended by the ADI Steering Committee were (1) accentuating the need for continued support from top management, (2) the setting of challenging competition goals for the services and emphasis on the use of the competition advocates in meeting these goals, (3) identification and elimination of barriers to competition, and (4) insuring competition is considered in the acquisition strategy of all programs reviewed by the Defense Systems Acquisition Review Council. On 5 May 1983, the new Deputy Secretary of Defense, Paul Thayer, consolidated the 32 initiatives into six (Table 5).

TABLE 5

CONSOLIDATED ACQUISITION IMPROVEMENT

PROGRAM INITIATIVES (5:5)

Consolidated Initiative	Corresponding AIP Action	
Program Stability	4	Program stability
Multiyear Procurement	3	Multiyear Procurement
Economic Production Rate	7	Economic Production rate
Realistic Budgeting	6	Budgeting to most likely cost
	11	Budgeting for Technological Risk
	18	Budgeting for Inflation
Improved Support and Readiness	9	System Support and Readiness
	12	Funding for Test Hardware
	16	Contracting Incentives for Support
	30	Logistics and Support Resources
	31	Improved Reliability and Resources
Encouraging Competition	32	Competition

The Federal Acquisition Regulation (FAR) was issued on 1 April 1984 replacing the Defense Acquisition Regulation. Part 7 of Volume 1 addresses acquisition planning and competition. The subparagraph on competition requires that the weapon system acquisition plan contain the following consideration:

> Describe how competition will be sought, promoted and sustained throughout the course of the acquisition. If noncompetitive contracting is being recommended, identify the source and discuss why competition can not be used [14:7-2].

Congress soon after passed the Competition in Contracting Act (CICA) of 1984. This law gave legal status to the services' competition advocates.

Procurement reforms by CICA amended the Armed Services Procurement Act in addition to two other existing federal procurement acts. CICA required the government to obtain "full and open competition" in procuring supplies and services. Also, CICA aided agencies in this task by eliminating the traditional bias toward formal advertising and permitting the government to employ the competitive procedure most suitable to the procurement situation. Seven exceptions to promoting competition were allowed, but the use of these exceptions was limited. The act specifically prohibited their use where there was a lack of advanced planning or a concern that funds for the requirement would not be made available in the future ("end-of-the-year spending") (45:1,3).

CICA also made changes to the general procurement process. Planning and solicitation guidance included "development of specifications in whatever manner is necessary to obtain 'full and open competition' and required advanced procurement planning and market research." CICA includes detailed instruction on when to notify industry, established a competition advocate office and required annual reports from the competition advocate (45:5-10).

The entire focus of CICA is competition and methods of effecting "free and open competition" in government procurement; sole source procurement is tightly controlled. CICA gives the DOD procurement process the latitude to employ the best method of competition consistant with the situation. In doing so, it recognizes dual sourcing as a valid form of competition and has made changes to the general procurement process to insure dual sourcing as well as other forms of competition are used.

Congress followed CICA with the Defense Procurement Reform Act of 1984. Clauses in this act address technical data issues, quality assurance tests of contractors prior to award and the procurement of products by the government which are also offered to the public (45:4). This act, like CICA seeks to foster competition within the private sector for DOD procurement.

Conclusion

A potential myriad of decision factors impact the dual source decision. Past decisions and current literature stress (1) market research, (2) weapon technology risk, (3) transfer of that risk to the second producer, (4) key contractual factors, and (5) lead time planning. The advantage of an effective dual sourcing initiative is most often -- a reduced acquisition price. Other advantages also exist. Dual sourcing broadens the defense industrial base and has resulted in improved weapon systems delivered on schedule. Dual sourcing does have risks. Large up-front funding can not be economically recovered for many years. Original price savings projected over future years become losses when volume is cut by DOD or Congress in the outyears of production. The Executive and Legislative branches of government heavily influence DOD procurement practices. Policy changes of the last ten years have permanantly changed DOD procurement policy. The latest policy change emphasizing competition began with the 32 procurement initiatives of then Deputy Secretary of Defense Carlucci in the 1981 Acquisition Improvement Program. Since then, the US Congress has added the Competition in Contracting Act of 1984, and the Defense Procurement Reform Act of 1984. Regulatory guidance continues to increase as government seeks to improve the DOD procurement system.

III. Methodology

The purpose of this chapter is to describe the underlying methodology concepts employed in this research effort. Specifically, the methodology objective, data sources, collection procedures, and data editing and grouping will be discussed.

Objective

The objective of the methodology is to collect accurate, reliable data from three sources; current dual sourcing literature, three prominent case studies and interview responses. The data provided from these sources will be the basis for revised dual source decision criteria on which to base dual sourcing decisions.

Data Sources

The three sources of data were chosen because of their comprehensive coverage of the dual sourcing field. Current literature on dual sourcing is quite vast. Numerous studies relate dual sourcing and competition improvement. The studies discuss a multitude of models and decision criteria all designed to aid the decision maker in a dual source decision.

Reviewing past dual sourcing actions and interviews with knowledgable contracting officers/policy people is a look beyond the theory to application. The three case studies were chosen on the basis of technical variety. GAU-8/A 30mm ammunition is a technologically simple, high

volume item which favorably meets many of the dual sourcing criteria cited in literature. The cruise missile engine and alternate fighter engine acquisitions inject technological complexity into the dual sourcing decision. This situation more closely represents current weapon acquisition actions.

Collection Procedures

The first two data sources were collected through routine searching of literature available in the Defense Technical Information Center, DIALOG, and other computer based reference services. The interviews were arranged through the Aeronautical Systems Division Contracting Office. They were able to identify those system program offices where dual sourcing contractual actions had been or were currently underway.

Interviewing the population of contracting officers/policy people familiar with dual sourcing is important. This group would provide data on the actual practices of decision makers and the dual sourcing decisions. Each contracting officer/policy person was interviewed using the interview guide in Appendix A. The definition of dual sourcing given in Chapter 1 prefaced each interview. That definition is, the splitting of a weapon's (or components) buy between two competitors, with the largest portion of the buy going to the lowest proposal.

Grouping and Analysis

The collected data will be grouped into the seven broad categories listed in chapter one (Table 6) and

will be supported by data collected from the interview guide. Each of the seven categories in turn, support the seven investigative questions of this thesis. From the investigative questions comes the data support for improved dual sourcing criteria. The relationship between the interview guide, data categories, and investigative questions is noted in Table 7. Data from each of the three data categories will be grouped on the basis of this table.

The comparison and contrasting of responses in data categories one through four support investigative questions one, two, three, and four (Table 7). These questions will provide the basis for determining the criteria which are the best predictor of dual sourcing outcomes. The comparing and contrasting of data groups five, six, and seven support investigative questions five and six. These investigative questions are the basis for determining both limiting and enhancing factors in the formalization of the dual source decisions process. These two results, criteria best predicting dual sourcing outcome and factors effecting formalization of the decision process combined with investigative question seven form the foundation for improved dual source decision criteria.

TABLE 6

DATA COLLECTION CATEGORIES

1) Reason for dual sourcing a weapon system

2) Criteria used in the dual sourcing decision

3) Competition decision process

4) Expected results of dual sourcing decisions

5) Results of dual sourcing decisions

6) Extent of decision formalization

7) Weapon systems characteristics inhibiting/enhancing the formalization of the decision process.

TABLE 7

RELATIONSHIP BETWEEN INTERVIEW GUIDE, DATA CATEGORIES AND INVESTIGATIVE QUESTIONS

INVESTIGATIVE QUESTIONS	DATA CATEGORY	INTERVIEW QUESTIONS
1. Is a logical decision process followed during planning for production competition of a weapon system?	-Reason for dual sourcing a weapon system -Criteria used in the dual sourcing decision -Competition decision process	1.2.3.4.5. 6.7.8.9
2. How does the decision process determine when to introduce a second source into the acquisition cycle?	-Competition decision process	1.2.3.4.5.6
3. Because of the current emphasis on competition and dual sourcing in the acquisition environment, how is the ultimate dual sourcing decision in the best interest of the government?	-Reason for dual sourcing	7.8.9
4. What were the expected results of past dual sourcing decisions?	-Expected results of dual sourcing decisions	8.9.10
5. Were these expectations met?	-Expected results of dual sourcing decisions -Results of dual sourcing decisions	8.9.10.11
6. Is the dual sourcing decisions so dependent upon the product in question that a common decision rule for all major weapon systems becomes impractical?	-Extent of decision formalization -Weapon system characteristics inhibiting/enhancing the formalization of the decision process	12.13.14 15.16
7. What influence has dual sourcing had on enhancing competition?	-none	17

IV. Results

Introduction

This chapter presents the data resulting from application of the methodology to actual dual source cases and interviews with Aeronautical Systems Division contracting officers/policy people. The remaining data source, dual sourcing literature was addressed in chapter two of this thesis. Each case study is prefaced by a brief background on the case. Secondly, the case is reviewed with respect to the interview questions in Appendix A. This data is then grouped and presented in its appropriate data category. Each interview response is grouped likewise and presented in the appropriate data category listed in chapter three. The final section aggregates the data by investigative question; chapter five draws from this information, conclusions and recommendations.

Case Studies

GAU-8/A 30mm Ammunition

Background. The A-10 Systems Program Office (SPO) initially procured the A-10 GAU-8/A 30mm Gun System and ammunition from General Electric. General Electric subcontracted Aerojet Ordinance and Manufacturing Company to provide the 30mm ammunition. In 1973, the A-10 program was preparing to enter full-scale development and the Air Force was conducting a competitive "fly off" between Northrup and

Fairchild. At the same time, the Air Force was also conducting a competitive teaming arrangement to determine the production source for the GAU-8/A Gun and ammunition. The first team was General Electric (GE) and Aerojet Ordinance and Manufacturing Company (AOC). The second team was Ford Aerospace and Honeywell Inc. The GE and AOC team won the competition in 1974 but GE was directed to develop a second ammunition source. GE selected Honeywell Inc. (HW) to be the second ammunition source (6:101).

The contract type, stipulation, methodology, and award split were unique. The dual sourcing contract was a form, fit, and function contract. Each contractor was to design their 30mm ammunition independently of the other. The designs of AOC and HW had to meet specific engineering criteria set forth in the contract. Each contractor had to maintain an industrial base equal to 60% of the annual mobilization production base or capable of producing 500 thousand rounds/month. The government made available $40 million in facility investment for Honeywell and Aerojet Ordinance and Manufacturing Company. AOC began low volume production in FY 1971-72. HW began production in FY75 (6:105). The A-10 program office utilized a unique method to split the yearly ammunition buy between HW and AOC. Based on the bids submitted by each company, the split was 50% - 50% (0% to .5% price differential). As the percent differential between the bids grew, the split approached 65% - 35% (11.5% to 12%

price differential). The division of the annual 30mm ammunition buy has consistently favored Aerojet Ordinance and Manufacturing Company (6:104-108).

Case Review. The decision to dual source the GAU-8/A gun ammunition was made by the Defense Systems Acquisition Review Council (DSARC) II meeting. This decision occurred at the Program Go-ahead point just prior to the beginning of the Full-Scale Development Phase. AOC produced the first lot of GAU-8/A 30mm ammunition during FY 1975; beginning in FY 1976, the Honeywell Corporation began their competition with Aerojet Ordinance and Manufacturing Company for the yearly purchases of ammunition. Essentially, both production sources were developed concurrently beginning with Full-Scale Development.

The DSARC II decision sought the attainment of three goals, the development of a second source to both expand the production base, to meet the production requirements, and to provide for production competition in the follow-on production years thus reducing procurement costs (29:40). None of the source material addressed the source selection process but emphasized the second sourcing was initiated to enhance the mobilization base (29:43). It can be assumed that Honeywell was chosen as the second source because it offered the best chance to attain the three goals of the DSARC II decision. The research data implies the impetus to dual source the GAU-8/A ammunition was from the top down, specifically the Defense Systems Acquisition Review Council.

Their reasons for the decision were threefold; a) build the industrial base, b) assure need quantities of ammunition are available and c) promote production competition.

The decision proved to be a very good one from both a cost savings and industrial base prospective. The price per round dropped on the average 75% from the three types of ammunition rounds purchased between the FY 1975 single year and FY 1982 fixed price multiyear contract (see Table 8) (6:111). The industrial base expansion benefitted from three provisions of the dual sourcing effort. First, with the form-fit-function methodology, it was reasoned both sources would produce a slightly different product, by only meeting form-fit-function requirements the supplier base would expand (29:41). Secondly, the split-buy determination process insures both production sources received enough of the yearly buy to stay in business. The last aspect of the GAU-8/A second sourcing action benefitting an expanded industrial base is a requirement to facilitize for peak production (60% of annual mobilization production). This assures the government excess production capacity exists to meet national emergencies (29:42.6:104).

The GAU-8/A 30mm ammunition case demonstrates the positive effects on dual sourcing potential of the need for a large number of simple items. The decision makers apparently without a formal process to aid them saw the opportunity to broaden the industrial base and still gain significant price reductions (Table 8) through production competition.

TABLE 8

GAU-8/A AMMUNITION COST REDUCTION (6:110,111)

	Estimated Average Price (by Fiscal Year)							
	75	76	77	78	79	80*	81*	82*
Aerojet Ordinance Company	20.22	13.01	8.99	6.74	5.79	4.73	4.37	4.25
Honeywell Corporation	-----	16.98	9.91	7.74	6.08	5.22	4.66	4.38

* Fixed price multi-year contract

Findings.

1. Data Category 1 - Reason for dual sourcing a weapon system

   a) enhancing the industrial base to meet schedule and mission considerations

   b) production competition resulting in a lower unit cost

2. Data Category 2 - Criteria used in the dual sourcing decision

   Initial decision

   a) large number of rounds needed

   b) simple technology

   Follow-on procurement

   a) meet form-fit-function requirements of the 30mm ammunition

   b) maintain an industrial production base at each producer equal to 60% of the anticipated annual buy

   c) offer the lowest price per round of ammunition

3. Data Category 3 - competition decision process

   - It can not be determined if a formalized decision process occurred. The decision to dual source the GAU-8/A ammunition did occur early in the life cycle of the A-10 weapon system (prior to FSD). The decision supported a need to reduce schedule risk by expanding the industrial base. Obviously, the market conditions and operational needs weighed heavily in the decision process. The decision process

also recognized the available opportunity to save dollars through competition.

4. Data Category 4 - Expected results of dual sourcing decisions

- The case study did not address expected results other than saying the dual sourcing of GAU-8/A ammunition was expected (with confidence) to result in greater industrial surge capacity and lower unit cost.

5. Data Category 5 - Results of dual sourcing decisions

a) an improved, expanded industrial capacity

b) on the average a 75% lower price

6. Data Category 6 - Extent of decision formalization

- The GAU-8/A decision does not appear to be highly formalized, but decision makers did assess the current market situation, mission needs, and available resources in coming to their decision.

7. Data Category 7 - Weapon system characteristics inhibiting/enhancing the formalization of the decision process

- Even though the GAU-8/A ammunition buy was not highly formalized, it demonstrates the advantages of a large and long production buy for a technologically simple item.

Cruise Missile Engine

Background. The Joint Cruise Missile Project Office (JCMPO) was established in September 1977 by the Under Secretary of Defense (Research and Engineering). The JCMPO combined the efforts of the Navy and Air Force project

offices developing the Surface and Submarine Launched Cruise Missile (SLCM), Air Launched Cruise Missile (ALCM), and Ground Launched Cruise Missile (GLCM) programs. The secretary's decision was designed to produce a cruise missile at minimum cost and minimum schedule delays. The secretary stressed a competitive "fly off" between Boeing and General Dynamics as well as a need to have component commonality between the ALCM, SLCM, and GLCM. The initial program manager, Rear Admiral Walter M. Locke, developed an acquisition strategy which included four dual sourcing operations. He proposed to dual source the 1) cruise missile engine, 2) reference measuring unit and computer/Inertial navigation element, 3) the missile assembly, and 4) the digital scene matching area correlation system. This case study just addresses the dual sourcing of the cruise missile engine. The JCMPO proposed to dual source the cruise missile engine using a directed licensing approach. The JCMPO was established after the initial engine R & D on the Williams Research Corporation engine (F-107), and the government did not possess the F-107 engine data rights. Williams Research Corporation (WRC), the developer, had proprietary rights for the F-107 engine. This engine had been chosen by the JCMPO to power all versions of the cruise missile. WRC did not have in place the production capacity to meet the cruise missile deployment schedule but assured JCMPO they could expand to meet the schedule.

The JCMPO informed WRC of the government's desire to dual source the F-107 engine. WRC refused to relinquish its proprietory data rights and license a second producer. The program office promptly issued a request in the Commerce Business Daily for an alternate cruise missile engine (ACE) meeting form-fit-function requirements. WRC interpreted this move as a threat and agreed to the original licensing agreement proposed by the JCMPO.

WRC was allowed by JCMPO to select the company it desired to work with in a licensing agreement. The JCMPO agreed to this arrangement because the ongoing "fly off" between Boeing and General Dynamics left few internal resources to devote to the selection of a second engine producer. Williams Research Corporation chose Teledyne CAE (TCAE) to become the second source.

Williams Research Corporation entered into a licensing agreement with TCAE and agreed to provide technical assistance including manufacturing drawings and techniques, tool design and process specification.

Case Review. The dual source decision in this case occurred after the consolidation of Air Force and Navy cruise missile program offices. Real Admiral Walter M. Locke, JCMPO director, developed an acquisition strategy promoting design and production competition (26:60). Included in his plan was the dual sourcing of the cruise missile engine. From the beginning of the JCMPO in September 1977, the Williams Research Corporation engine, F-107, was deemed

superior to all other entrees and was selected to be the standard engine in all variants of the cruise missile. JCMPO decided at that time to second source the F-107 engine. They were interested in attaining three goals a) expanded production capacity, b) cost control through the presence of a second competitive source and c) reduction of schedule slippage risk due to technical or economic reasons. A secondary reason behind dual sourcing the F-107 engine was to gain a more responsive WRC (26:61,62).

WRC was not initially receptive to the idea of relinquishing their data rights to develop a second source. The JCMPO used the threat of competition from a potential alternate cruise missile engine to force WRC's acceptance of a dual sourcing effort. In August 1978, WRC finally agreed to the direct licensing agreement. The government and WRC eventually agreed upon Teledyne CAE as a suitable second source technically capable of becoming a qualified source for F-107 engines (26:64,65).

It is difficult to determine which source of influence was greater in initiating this dual sourcing action, Under Secretary of Defense for Research and Engineering or WRC's then current inability to meet projected mission needs. The program directive charged the JCMPO to produce the project at minimum cost and minimum schedule delay (26:59).

The F-107 dual sourcing decision appears to have been made with a high degree of certainty. Early history of the implementation phase cast some doubt on this high level

of certainty. WRC was tasked with qualifying Teledyne CAE (TCAE) as a producer by fiscal year 1982. As of 1980, the technology transfer between WRC and TCAE was one year behind schedule. Several reasons for the schedule slippage were given by JCMPO personnel. The main reason cited was a lack of a "motivational factor" prompting WRC to execute the terms of the direct licensing agreement. At that time this deficiency was being corrected (26:66).

The government's non-ownership of the F-107 engine data caused the bulk of problems associated with this dual source case. This case also highlights how having sufficient production numbers favorably impact the dual sourcing decision. Sufficient production numbers of SLCM, ALCM, and GLCM were anticipated over which the non-recoverable start up costs could be spread. Table 9 specifies the difference in non-recoverable costs associated with the directed licensing and alternate cruise missile engine approach. Clearly, the start up costs for an alternate engine are prohibitively high, thus favoring the directed licensing approach taken by the government. The additional costs to develop an alternate engine and support its logistical needs are significant. Sole source costs to produce 4790 units (assumed mission needs) would be $356.6 million (4:90). The $19.5 million up front costs associated with a directed licensing contracting approach are more reasonably recoverable than the up front costs of the range of $72.2 to $147.8 million associated with the alternate fighter engine approach (Table 9).

TABLE 9

SUMMARY OF COST ESTIMATES OF SECOND SOURCE ALTERNATIVES FOR THE CRUISE MISSILE ENGINE (4:87)

(Millions of $ FY87)

	Directed Licensing	Alternative Design
RDT&E	0	66.9-109.7
Advanced development	0	26.9- 46.0
Full scale development	0	32.2- 48.1
Qualification test	0	7.8- 15.6
NONRECURRING INVESTMENT	19.5	2.0- 5.5
Technology transfer	15.0	0
Tooling and test equipment	4.5	2.0- 5.5
SUPPORT	0	3.3- 32.6
Integrated Logistics Support	0	3.3- 11.6
Spares	0	0 - 8.3
Maintenance	0	0
Maintenance data	0	0 - 0.7
Technical publications	0	0 - 0.5
Support equipment	0	0 - 1.3
Training	0	0 - 0.3
Inventory management	0	0 - 0.5
Operational Test	0	0 - 21.0
TOTAL	19.5	72.2-147.8

The assumptions of the formal acquisition strategy are not discussed in the case, therefore, the generalization of these assumptions to other weapon systems/components can not be determined. Regardless, the available data suggests the decision to dual source was a good one which has impacted competition. Cost savings of $19 million is an achievable goal considering total sole source costs of $356.6 million. The program office in 1980 was correcting the major management deficiencies necessary in eliciting full support for the dual sourcing action from Williams Research Corporation.

Findings.

1. Data Category 1 - Reason for dual sourcing a weapon system

   a) expand industrial capacity

   b) control/reduce unit price

   c) reduce schedule risk

2. Data Category 2 - Criteria used in the dual sourcing decision

   a) the technically superior produce of WRC

   b) lack of sufficient production facilities at WRC to meet projected needs

   c) TCAE's capability to perform the work

3. Data Category 3 - Competition decision process

   - A formal acquisition strategy was developed by the JCMPO in which competition was addressed. The literature does not identify on what criteria the decision was based, it can be concluded that economic considerations were dominant.

4. Data Category 4 - Expected results of dual sourcing decisions

- The program office expected with full confidence to achieve industrial base expansion and lower unit prices.

5. Data Category 5 - Results of dual sourcing decisions

- The data sources do not provide any results. They do state the implementation was one year behind schedule as of 30 September 1980 but, the program discrepancies were being corrected.

6. Data Category 6 - Extent of decision formalization

- The decision process is formalized and contained in the acquisition Strategy Plan developed prior to Full Scale Demonstration ("fly off").

7. Data Category 7 - Weapon system characteristics inhibiting/enhancing the formalization of the decision process

- Lack of data rights ownership by the government reduces the methods of competition available to the government. Additionally, lack of data rights complicates acquisition planning by the program office. The large number of engines being procured for Air Force and Navy weapon systems enhances formalization of the decision process. A larger production quantity opens up more potential competition strategies. With both services effected, a broader political base exists advocating continued support for the program.

Alternate Fighter Engine for F-15 and F-16

Background. Pratt and Whitney Aircraft Group of United Technologies was the original producer of the F-100 engine used in the F-15 and F-16. They began producing the F-100 engine in 1974. Because of numerous problems with performance, spare parts, and availability, the Air Force (joint Air Force and Navy effort) began development of an alternate fighter engine. Developmental competition between General Electric and Pratt and Whitney began in FY 1979. GE produced the F-110-GE-100 engine and Pratt and Whitney produced the F-100-PW-220.

In May 1983, the decision was made to procure FY 1985 F-15 and F-16 engine requirements from both producers. One hundred twenty engines for F-16 aircraft and 40 engines for F-16 aircraft would be procured from General Electric and Pratt and Whitney respectively (10:3). FY 1986 procurement splits has the Air Force buying 184 engines (54%) from General Electric and 159 engines (46%) from Pratt and Whitney (42:64).

Case Review. The alternate fighter engine (AFE) was initially funded in fiscal year 1979 anticipating the first production buy to be delivered in 1986 (awarded in February 1984). It was intended in 1979 that both producers would be carried through the entire acquisition cycle as parallel production sources (10:2.46:64). The decision criteria behind the desire to dual source future engine procurements were three-fold. Then current F-100 fighter

engines were "much less durable and reliable than desired," driving up the life-cycle cost of the engine (46:64). The goal of the AFE program was to rectify the durability and reliability problems yet retain the desired performance thrust-to-weight ratio (46:64). The General Electric (GE) and Pratt and Whitney (PW) offers were evaluated with respect to the following criteria [10:4]:

a) overall capability

b) readiness and support

c) life-cycle cost

d) program adequacy and competition

e) past performance

f) various on-site review

The Air Force wanted to use competition to obtain an engine which improved operability, safety, durability, supportability, reduced life-cycle cost and a broadened industrial base (10:2). The program office saw competition as the method through which these goals could best be attained.

The quality of the decision while unproven, appears to be very good. Senior Air Force officials say both engine prototypes "do exactly what they are supposed to do" (46:64). Officials say the competitive methodology will have saved between two and four billion dollars over the anticipated six year life of the program and deliver a product with twice the engine core life and one-half of the maintenance costs of the F-100 (40:18).

The source selection looks at competition in co-production and procurement of spare parts. Co-production competition evaluated the price charged when the award of a yearly buy was split versus the price for 100% of the award. The Air Force wanted to eventually dual source spare part procurement. To do so the prime contractor needed to show flexibility in second sourcing its subcontractor support. In both evaluations General Electric had the better proposal. GE's proposal contained special provisions for the Air Force in dual sourcing the lower tier contractors and offered a lower price per unit in a split-production award than the PW proposal (10:5,7). Since both engines were technically equal, the award split for FY 1984 and 1985 awards was based on the superior competition clauses in the General Electric proposal. For fiscal years 1986 through 1990 awards, all contract options are open, even a single award. After all qualification tests are completed, the experience of the producer and quality of the product will greatly influence the award split (10:8.9).

The AFE acquisition is still in source selection for future buys thus, the data necessary to determine decision formalization potential is not available. Considering the acquisition plan called for dual sourcing five years prior to the first production lot award, much planning was conducted early in the program. One can hypothesize that the large numbers of engines needed, reduced life-cycle

costs of the two engines, past performance and capabilities of GE and PW, and improved engine durability and performance enhanced the dual sourcing potential. These factors can be quantified and be made a part of a formalized decision process specific to jet engines.

The competitive results of the initial 75/25 contract award to GE and PW are mixed. If all 2000 engines had been awarded to one source a cost savings of 15% over sole source procurement from program inception would have been realized. A dual production award reduces this savings to 10%. The Secretary of the Air Force defends the dual award. A dual award will reap additional cost reductions to future buys, more contractor responsiveness, enlarged industrial base, and protection against work stoppages through a strengthened subcontractor base (10:8). Over the life of the AFE program dual sourcing reduces unit procurement cost and life-cycle costs, yielding a higher quality fighter engine.

Findings.

1. Data Category 1 - Reason for dual sourcing a weapon system

a) improved operability

b) safety

c) durability

d) supportability

e) reduced life-cycle cost

f) a broadened industrial base

2. Data Category 2 - Criteria used in the dual sourcing decision

a) overall technical capability and associated durability and reliability

b) readiness and support factors

c) projected life-cycle costs

d) program adequacy and competition

e) past contractor performance

f) various on-site reviews

3. Data Category 3 - Competition decision process

- The competition between GE and PW began in the development phase of the acquisition cycle. Both producers are being carried through the entire acquisition process. The source selection process expanded the three previously mentioned criteria into six and also looked at the potential dual sourcing of spares for each engine. The initial production split was based heavily on this factor. Future production splits will consider to a greater degree product quality.

4. Data Category 4 - Expected results of dual sourcing decisions

- It is too early in the acquisition to report results. But the Air Force confidently expects to receive the following benefits:

a) lower unit cost and life-cycle cost

b) extended engine life with one-half the maintenance.

c) broadened industrial base

5. Data Category 5 - Results of dual sourcing decisions

- The program is too young to provide any data for this category.

6. Data Category 6 - Extent of decision formalization

- The decision appears to be thought out and planned well in advance of production. The dual source decision could be formalized to the extent of applying specifically to engine procurement actions.

7. Data Category 7 - Weapon system characteristics inhibiting/enhancing the formalization of the decision process

- The early success of the alternate fighter engine program was enhanced by a) large number of engines needed, b) a capable industrial base able to support competition and c) extensive early planning.

Interviews

Five interviews were conducted with contracting officers in ASD. The first interview involved ASD personnel closely associated with competition and dual sourcing policy. The remaining four interviews examined specific dual sourcing programs in the planning and production phases of the acquisition cycle.

ASD/PMP. Mr. Vern Cockeran ASD/PMP Chief of Contract Division Policy and Mr. Al Miller ASD/Competition Advocacy, Chief of Staff.

Interview Summary. During the interview Mr. Cockeran and Mr. Miller discussed the dual sourcing policy of ASD and the competition review process followed by ASD.

Planning for program competition (if appropriate, dual sourcing) begins early in the acquisition cycle of a weapon system. Planning begins approximately four to six months prior to the release of a Request for Proposal (RFP) and prior to the Business Strategy Panel meeting on which both men sit. The program office also consults the policy chief and competition advocacy office during the preparation of the RFP for initial and follow-on acquisitions. Follow-on acquisitions involving a sole source require a justification and authority (J & A) to be issued by the program office. All J & A's are reviewed by the competition advocate's office. If the dollar amount is above $10 million, the J & A approval process begins three to four months prior to the release of the RFP and must be approved at the Secretary of the Air Force level.

New programs or programs in the follow-on buy stage of the acquisition cycle undergo three types of analysis: economic, technical, and program (Table 10). The final decision to dual source a weapon system or subcomponent is based on the results of the three types of analysis and is always program specific. The results of the analysis also dictate the type of competition strategy employed; if dual sourcing, when the second source will be introduced into the acquisition cycle.

TABLE 10

COMPETITION ANALYSIS

1) economic
   - Is it a good investment?
   - How are maintenance and logistical cost effected?
   - Are production requirements sufficient to support two sources?
   - Do we have funds to cover the initial investment?

2) technical
   - What is the level and type of technology inherent in the systems design and manufacturing process?
   - How does it influence technology transfer, source selection, program schedule, and economic analysis?

3) program
   - What are the key program issues, risks, and time schedule?
   - What shape is the prime's subcontractor support in?
   - Are there limited critical subcontractors?
   - How much subcontracting will there be?
   - Is the prime contractor technically capable?

The pressure to dual source comes from both regulation and program managers. CICA and recent guidance from the Air Force Competition Advocate insist all new acquisitions be reviewed to determine if second sourcing is practical. Often these reviews are scrutinized by many management levels. A recommendation for a sole production source guarantees a high level review.

When the decision to dual source is made, no one reason dominates. Often the benefit of sustained competition between two sources is economic or meeting the program schedule. Mr. Cockeran and Mr. Miller were ambivalent with respect to the reliability of the dual sourcing decision. They felt it was often difficult to determine the exact savings attributable to dual sourcing and that programs change over time, sometimes invalidating assumptions of the original program. Mr. Miller considered the quality of the dual source decision to be unchanged, that only the models have improved. Still, the models can not anticipate accurately many pragmatic factors or anticipate major program changes. The three hinderances to improved confidence in the dual source decision are determining actual savings, anticipating major program changes, and quantifying program factors.

The final decision to dual source can never be totally formalized. Program managers must take into consideration such things as intangible benefits, program specific items, and established assumptions on which computer analysis can be done.

The Congressional desire to see more dual sourcing has not yet significantly affected ASD's dual sourcing percentage of procurement dollars. It was emphasized that all of the ASD dual sourcing programs were initiated prior to CICA. Today, CICA forces all major programs to seriously and systematically consider dual sourcing in the acquisition plan.

Findings.

1. Data Category 1 - Reason for dual sourcing a weapon system

   a) economic - save money

   b) insure program schedule is met

2. Data Category 2 - Criteria used in the dual sourcing decision

   - The economic, technical and program specific criteria are looked at in determining if dual sourcing is an appropriate competition strategy (see Table 10).

3. Data Category 3 - Competition decision process

   - Planning for competition begins four to six months prior to and at the Business Strategy panel. They look at the above analysis and review the source selection criteria (prepared by the program office). If warranted, dual sourcing is pursued.

4. Data Category 4 - Expected results of dual sourcing decision

   - no data provided

5. Data Category 5 - Results of dual sourcing decisions

- Overall, the results of saving dollars and meeting program schedules has been achieved.

6. Data Category 6 - Extent of decision formalization

- It can be structured to the extent of requiring three types of analysis; economic, technical, and program. Completion of these analyses require the program office to make assumptions and project into the future. This introduces uncertainty into the system. The program manager makes the final decision based on the less than perfect results of the three analyses.

7. Data Category 7 - Weapon system characteristics inhibiting/enhancing the formalization of the decision process

- The program specific concerns are often subjective and do not lend themselves to a structured process. The measurement of intangible benefits and program assumptions introduce uncertainty into the process, thus inhibiting complete formalization.

ASD/AE. Mr. Claus Perry ASD/AE Chief Civilian Advisor

Interview Summary. Mr. Perry discussed the leader-follower (L-F) dual sourcing strategy used to procure the Advanced Concept Ejection System (ACES). Initially, the ejection seat was a sole source item but follow-on buys for the combined Navy and Air Force requirements raised the question about competition. The Air Force and Navy contractors were competed against each other, then one winner was chosen.

However, it was decided to take the winning design and execute a leader-follower production arrangement. The goal of the L-F action was to eventually have a contract buy-out competition between the two production sources.

Criteria which keyed decision makers to consider dual sourcing were as follows:

a) a large requirement for ejection seats

b) did not want a sole production source

c) expanded industrial base desired

It was the hope of program managers that a better product and lower price would result from the competition.

The idea to dual source ACE was first raised by senior AFSC management. This being AE's first L-F contract, there was resistance to it. As time progressed, both AE and the user SPO's became educated and grew to strongly support the program.

Generally speaking, reasons to dual source vary with the program, its circumstances, and resources (government and industry) available. These very factors will also dictate when a second source is introduced into the procurement cycle. Resources in general, have a profound effect on the ease of introducing a second source. A L-F arrangement requires up front funding from Congress and a large inhouse effort to manage it. Industry resources or market conditions effect the availability of willing alternate production sources. A strong, well advanced sole source will reduce

the interest of other capable producers to compete. Generally, ASD/AE competes procurements through the R & D and FSD acquisition phases then chooses one production source. After this sole source begins production, dual sourcing is investigated in the follow-on buys via a technical data package (TDP) arrangement.

Mr. Perry was very confident about the ACES decision, despite the lack of supporting evidence. Factors effecting the quality of the dual sourcing decision are the number of units to be purchased, data rights ownership and interest by other industry members in being a competing source.

The formalization of the dual sourcing decision is limited according to Mr. Perry. In the ACES decision, the economic analysis did not support the presence of a second source. This may partially be caused by the difficulty of quantifying the savings attributable to dual sourcing. These savings are based on a hypothetical sole source price. Determining this price in the out years of a production buy is "shaky".

Competition between two sources works as ASD/AE. The Aeronautical Systems Division percentage of FY 1985 procurement dollars competed is 35%, the ASD/AE rate is 80%. ASD/AE dual sources because it yields a better product at a lower cost not because it is the law. The results take significant lead time, up front money, and program office effort to effectively execute.

Findings.

1. Data Category 1 - Reason for dual sourcing a weapon system

   a) lower unit cost

   b) expand industrial base

   c) higher quality product

2. Data Category 2 - Criteria used in the dual sourcing decision

   a) a projected large requirement for ejection seats

   b) the existance of a sole production source

   c) the desire to expand the industrial base

   d) the need for 100% reliability

3. Data Category 3 - Competition decision process

   - During Business Strategy meetings covering follow-on buys for ACES, initial thought was given to combining the Air Force and Navy requirements then, dual sourcing via leader-follower. The above criteria were recognized as advantageous to dual sourcing. The leader-follower technique was chosen because of the need to have a 100% reliable seat.

4. Data Category 4 - Expected results of dual sourcing decisions

   - Mr. Perry was confident ACES' dual sourcing will eventually result in a lower purchase price, expanded industrial base, and a higher quality product.

5. Data Category 5 - Results of dual sourcing decisions

- Both lower prices and better products have been realized by ASD/AE, but no details were available.

6. Data Category 6 - Extent of decision formalization

- It is limited at best based on ACES. The economic analysis did not support the dual sourcing of the program, but results are being seen. Also it is tough to accurately quantify the savings of dual sourcing. Projecting sole source costs against which dual source costs are measured is questionable at best.

7. Data Category 7 - Weapon system characteristics inhibiting/enhancing the formalization of the decision process

- Enhancing characteristics of the ACES program were:
  a) need for large numbers
  b) other contractors interested in competing with the sole source
- Inhibiting characteristics of the ACES program were:
  a) projecting out year savings
  b) no interest in the market place

Major Robert F. Munoz

Interview Summary. Major Munoz developed the split award method used by the Maverick SPO in dividing production quantities of the IR Maverick missile. His method was a modification of the 1Lt Gary T. Sparrow and Capt James A. Stevens September 1983 AFIT thesis. The decision to dual source came eight years before the first equal competition

between the sources. At the completion of full-scale development and prior to the release of the IR Maverick missile RFP, the program history and missile technical risk was reviewed. Decision makers found the projected unit price to be high, but found the IR Maverick missile to have an acceptable (technical) risk for dual sourcing. Source selection criteria for the second source were technical factors, management factors and cost. Raytheon was selected to be second source in a leader-follower competition strategy.

Raytheon was given thirty months to qualify the production facility plus an initial production lot to be awarded in FY86. An August 1985 SPO Business Strategy meeting reviewed the split award method developed by Major Munoz for use in FY 1987, the first year of equal production competition. Their primary focus was price competition and secondly, the maintenance of two productions sources so that the second source can compete for 50% of the follow-on year purchase.

There was no intense pressure to dual source the IR Maverick missile. The decision was based on a sound business principle -- the need for a lower unit price.

Major Munoz felt that two factors continue to prevent more effective dual sourcing. The uncertainty in projecting out year requirements for a weapon system making it difficult to estimate the long term savings of dual sourcing. For it is in the later years of a production run that dual

sourcing "pays off". Cut the out year buy and the up front cost has fewer units over which to be spread, thus increasing unit and total procurement costs. The second factor is good technical data. The technical data for the IR Maverick was inadequate to conduct a standard TDP dual source action and thus a leader-follower dual sourcing action was necessary.

Two factors of the IR Maverick acquisition enhanced its dual sourcing potential. The program encompassed a sufficiently large buy over a long program life. These two factors provided a good production base over which to off-set the up front costs of establishing Raytheon as a second source.

Major Munoz did think the dual source decision could be highly formalized. Since, dual sourcing saves the government money in the later years of a program, the decision maker must estimate congressional and high-level DOD support for a program. Without this support in the out years of a program, the yearly buys could be cut thereby reducing or nullifying the savings attributable to dual sourcing. No computer can estimate these factors.

Findings.

1. Data Category 1 - Reason for dual sourcing a weapon system

- The two reasons for dual sourcing the IR Maverick were the desire to reduce the price through competition and the maintenance of this competition over the life of the acquisition or until a program buy-out.

2. Data Category 2 - Criteria used in the dual sourcing decision

a) complexity of the weapon system

b) quantity of the weapons buy

c) length of the procurement

d) management factors

e) cost

f) technical capability of the second source

3. Data Category 3 - Competition decision process

- The decision to dual source the IR version of the Maverick missile was made by the program office approximately eight years before the first equal competition between the sources. The decision resulted from a review of program history through full-scale development and an assessment of the technical risk associated with the new missile. The second production source was chosen based on the criteria listed in data category one. The dual source decision is implemented with the competitive source selection now in process. The goal of which is to maintain a high level of prive competition, thereby lowering the unit cost of the weapon system. The savings are estimated over the life of the program.

4. Data Category 4 - Expected results of dual sourcing decisions

- Because no procurement of the IR Maverick has occurred, no data exists. Major Munoz is confident the unit cost will

drop and that both production sources will be maintained by the use of the split award methodology.

5. Data Category 5 - Results of dual sourcing decisions

- The closest comparable missile acquisition is the TV guided version of the Maverick missile which was a sole source procurement and less complex than the IR Maverick missile.

6. Data Category 6 - Extent of decision formalization

- It is not likely the dual source decision can be highly formalized. The political support necessary to sustain program buys in the out years cannot be formalized or quantified in an equation.

7. Data Category 7 - Weapon system characteristics inhibiting/enhancing the formalization of the decision process

enhancing -

a) need for a large number to be produced

b) acceptable technical risk associated with the acquisition

inhibiting -

a) uncertainty of out year support

b) poor technical data package

ASD/YY. Ms. Elizabeth Louis and Mr. Jim Adams ASD/YY

Interview Summary. Ms. Louis is a contracting officer with the Aeronautical Systems Division Strategic SPO. Mr. Adams works in the program control office of the same organization. Ms. Louis works with the Short Range Attack Missile II (SRAM II) acquisition while Mr. Adams worked on the acquisition strategy for SRAM II.

The SRAM II program was officially approved by the Defense Resources Board in July 1983 with an Initial Operating Capability of FY92. In February 1985 pre-FSD funding from Congress supported technical risk reduction work by three contractors. By March 1986, the three subcontractors had successfully reduced the overall technical risk to low to moderate. This result minimized the benefit gained from potential FSD competition. Usually, FSD competition is used to reduce the technical risk associated with a state-of-the-art program. Additionally, FSD funding had been constrained. Because of these two developments, current source selection proceedings are competitively choosing an FSD contractor (37:2-4).

The program office for SRAM II commissioned The Competition Analysis Center of The Analytic Science Corporation (TASC) to do a competition study on SRAM II in accordance with AFSC policy for dual sourcing. This study was completed in June 1986, approximately five years prior to low rate initial production. The briefings based on this study received high level AFSC overview and based on these briefings, the decision was made to dual source three major subsystems of SRAM II. This decision reflected the low to moderate technical risk assessment, FSD funding constraint, the fact that 85% of procurement dollars are expended at the subcontractor level, and a desire to avoid the subcontractor problems experienced in the ALCM program (37:3,4). The program office opted to dual source three major subcomponents. The program office

felt the cost associated with the TDP or a L-F dual source method for the entire weapon system was too high. The criteria considered in source selection was primarily economic but schedule and industrial base improvement were also considered. The basic contract for FSD includes purchase options for low rate initial production and a portion of the lot 1 buy. Future source selection for follow-on buys will stress proposals that further dual sourcing goals in the acquisition plan. The planned acquisition strategy is designed to yield SRAM II missiles using minimum up front funding and lower production risk at the lowest possible cost (Table 11) (37:6).

Both interviewees felt production numbers tend to influence the introduction of a second source. SRAM II does not have a high anticipated production volume thus precluding the use of a TDP or L-F methodology in the follow-on buy's acquisition stage.

Except for CICA pressure and general pressure in the acquisition community to dual source, there does not appear to be any undue pressure to dual source SRAM II. Both interviewees felt confident that the schedule and industrial base expansion would be achieved. They were less confident about the price reduction goal. There was some concern that the SRAM II buy might be cut reducing or nullifying any potential cost savings. As Ms. Louis stated, "Receipt of the contract proposals should provide real insight into the cost effectiveness and viability of dual sourcing."

TABLE 11

SRAM II LEADER-FOLLOWER COSTS

(millions of FY83 dollars)

Cost Element	Missile	Nav/Guidance	Actuator	Rocket
Single Source	891.82	436.07	48.25	246.26
Leader-Follower	810.13	392.36	44.92	178.23
Gross Savings	81.69	43.71	3.33	64.03
Nonrecurring	110.00	33.50	1.60	23.00
Net Savings	-28.31	10.21	1.73	41.03

Based on their SRAM II background, both people interviewed saw the availability of government up front funding and estimating competition savings to be factors inhibiting dual sourcing. On a broader perspective funding was felt to be a positive (if present) or a negative (if absent) factor in dual source success. Moreover, funding changes and programs change - the program you plan for is not always the program you buy.

Formalization of the dual source decision process was deemed possible but, only eventually. The competition data base is too weak to support decision formalization now but could in future acquisitions. The impact of dual sourcing, and its eventual formalization, was felt to be positive. CICA, competition and resultant dual sourcing policy force all program offices to evaluate their programs for dual sourcing potential. This is desirable, but difficult to do. Difficult with respect to assumptions of the analysis and projecting out year costs and savings.

Findings.

1. Data Category 1 - Reason for dual sourcing a weapon system

    a) industrial expansion

    b) price reduction

    c) meeting the schedule

2. Data Category 2 - Critieria used in the dual sourcing decision

a) low to moderate technical risk

b) FSD funding cut

c) 85% of procurement dollars expended at subcontractor level

d) avoidance of past subcontractor problems in similar programs

3. Data Category 3 - Competition decision process

- The TASC study was complete five years prior to low rate initial production. It looked at a leader-follower strategy at the prime and subcontractor level. Given the criteria listed above, dual sourcing at the subcontractor level was deemed economically feasible (see Table 11).

4. Data Category 4 - Expected results of dual sourcing decisions

- It is expected the dual sourcing of SRAM II major components will expand the subcontractor industrial base thus enhancing schedule attainment. There is less confidence that dual sourcing will reduce the acquisition costs.

5. Data Category 5 - Results of dual sourcing decisions

- SRAM II is the first dual sourcing effort undertaken by Ms. Louis and Mr. Adams.

6. Data Category 6 - Extent of decision formalization

- Both of the people interviewed felt formalization was possible and good for the acquisition community. Through formalization each new program would be assessed for dual sourcing potential in a uniform manner.

7. Data Category 7 - Weapon system characteristics inhibiting/enhancing the formalization of the decision process

- Availability of government funding was seen as the most important factor negatively impacting the SRAM II dual sourcing program. The low to moderate technical risk definitely enhances future dual sourcing success. As stated by Ms. Louis, receipt of FSD proposals should provide real insight into the viability of dual sourcing.

Mr. Bob Lawson. Chief Plans and Requirements Division, Directorate of Propulsion Logistics

Interview Summary. Mr. Lawson discussed the Air Force efforts to dual source replenishment spare (RS) parts for the F-100-PW-220 engine from Pratt and Whitney and F-110-GE-100 engine from General Electric. The decision to dual source RS was primarily an economic decision designed to save money. Secondary reasons were RS quality improvement (reduced life-cycle cost) and avoidance of schedule delays.

Mr. Lloyd K. Mosemann, Deputy Assistant Secretary of Defense for Logistics and Communications initiated the proposal. This requested action came two to three years prior to the first RS buy. Proposals offered by GE and PW identified the top 30 high value critical RS on their respective engines that could be dual sourced. The program office used a Lotus 1-2-3 computer program to evaluate both proposals. The program modeled the type of costs associated with establishing the second source (Table 12), maintaining the second

TABLE 12

COSTS TO ESTABLISH AND MAINTAIN A DUAL SOURCE

* - Data Rights and Data Package

* - Qualification Costs

* - Initial Tooling

* - Test Sample

* - Engine Test

* - Technical Support

- Manpower to Coordinate Effort

- On-going Quality Control

- Maintaining Specifications

- Tracking System for Serialized Parts

(* Cost Estimates Provided by Prime/Reasonableness Verified by the Air Force)

source (Table 12), and resultant savings/losses. The analysis approach began with three assumptions: a) 20% savings on item purchased, b) 10 and 20 year life cycles, and c) the government would contract directly with the vendors for RS. The model simply subtracted the cost to establish and maintain a second source from the expected savings yielding net savings (loss). The minimum return on investment to set up the second source was 10%. Of the 30 parts none of the GE parts were deemed economically justified. The study concluded GE and PW had dual sourced the best components of their respective fighter engines without any prompting or direct funding from the government. The study recommended the prime contractors be encouraged (incentivized) through annual competition to continue dual sourcing of the replenishment spares. These results and recommendations would not have happened if competition for the Air Force and Navy fighter engine business had not exerted price and quality pressure upon the competing sources.

Mr. Lawson assumed the dual source decision process could be formalized. Once formalized, assumptions underlying the process are accepted as fact. This eliminates the points of contention present when each program office develops their own set of assumptions.

Formalized or not, competition has been good for logistics at the SPO level in the acquisition cycle. At this level, logistics is concerned with doing those things "up

front" to reduce system life cycle costs. Competition and the mandate to dual source has reduced life cycle costs.

Findings.

1. Data Category 1 - Reason for dual sourcing a weapon system

- Aircraft engine logistics has the desire and will to decrease engine life cycle costs.

2. Data Category 2 - Criteria used in the dual sourcing decision

- The major criteria was the potential reduction of replenishment spares cost realized by dual sourcing.

3. Data Category 3 - Competition decision process

- The program office evaluated the proposals offered by GE and PW using a computer program. For an RS to be economically viable, it had to have a return on investment of 10% or greater. The program estimated the cost of each line item in Table 12 or received cost estimates provided by the prime contractor. From this, estimated savings or losses were generated.

4. Data Category 4 - Expected results of dual sourcing decisions

- Few parts were identified as potentially dual sourcable. This was attributed to competition between GE and PW. Today, only 4% of the GE engine replenishment spares and 5% of the PW engine replenishment spares are single sourced. Mr. Lawson felt these results were motivated by quality and schedule

concerns of the prime contractor. The results expected by the government were lower purchase cost of RS, lower life-cycle costs, and expanded industrial base.

5. Data Category 5 - Results of dual sourcing decisions
   - not applicable
6. Data Category 6 - Extent of decision formalization
   - Mr. Lawson assumes the dual source decision can be formalized. This would be very desirable because it removes from discussion the assumptions on which the formalized process is based.
7. Data Category 7 - Weapon system characteristics inhibiting/enhancing the formalization of the decision process
   - not answered in this interview

Data Grouping by Investigative Question

The final data analysis task involves its aggregation under the seven investigative questions. Table seven, found in chapter three, describes how the data categories support the investigative questions. Listed below are each of the investigative questions followed by a summation of findings from the three data sources.

Investigative question 1 - Is a logical decision process followed during planning for production competition of a major weapon system?

Planning for competition at any phase of the acquisition cycle begins early in the program history and is highly

structured. Planning for competition is a major premise of the Competition in Contracting Act. Competition planning was stressed heavily by Major General Weiss, the Commander of the Air Force Contract Management Division and General Skantz, Commander of Air Force Systems Command at the First Air Force Competition Advocate Conference. In the field, competition planning definitely happens. The GAU-8/A ammunition began competition planning before Full-Scale Development. The Joint Cruise Missile Program Office began their competition planning upon receipt of the program charter. ASD conducts Business Strategy Panel meetings prior to the issuance of the RFP; discussion acquisition and competition strategy for the pending program. At ASD, all new programs undergo an economic, technical and program analysis to determine the feasibility of dual sourcing and the specific type desired. Planning is done early and in depth.

Competition planning involves the logical examination and assessment of num erous criteria. While the program office has definite reasons for undertaking a dual sourcing acquisition strategy, determining how to execute this strategy is quite complicated. Appendix B is the latest guidance from the AFSC Competition Advocate on "Determining the Use of Competitive Multiple Sources." The multiple source analysis report required by this policy letter, requires the program office to state the baseline assumptions for the selected competition strategy. The assumptions are grouped into four

categories: a) funding, b) quantity (total and rate), c) schedule, and d) other. These four categories are not as simple to assess as appearances imply. The economic, technical and program analysis used at ASD forces the program office to make many subjective estimates (Table 10). On a broader perspective, the many criteria noted in chapter two must also be considered. The interviews repeated many of those same criteria listed in chapter two but added two new criteria which impact the dual sourcing decision. They are the existance of a sole source and avoidance of past subcontractor problems in similar programs. The interviews noted the political nature of funding DOD weapon acquisitions. The assessment of numerous competition decision criteria is influenced by political pressures and subjective criteria. This sturcture aids the decision maker in reducing the complexity of the competition decision at the risk of overly simplifying subjective criteria.

Investigative question 2 - How does the decision process determine when to introduce a second source into the acquisition cycle?

Support for investigative question 2 comes from the three case studies and five interviews. Over time, the decision process has become more mechanized. Decision makers in the GAU-8/A ammunition case considered the market condition, schedule, and mission need. It is undeterminable from the

literature if this was a step-by-step process or adhoc process. In some programs, such as the Alternate Fighter Engine and IR Maverick missile, the question is not when to introduce the second source but what will the production split be?

From a policy perspective, the introduction of a second source ties closely to the outcome of the economic, technical and program analysis performed by the program office. Specific factors within these analyses effect dual source implementation more than others. In the ACES program the presence of a qualifiable second source favorably impacted the dual source potential. In the IR Maverick situation, an experienced sole source existed, but negatively impacted the dual sourcing potential. The SRAM II situation demonstrated the criticality of up front funding. In the replenishment spares case, return on the investment was the discerning factor in dual sourcing. Noted throughout the findings, number of systems/items to be produced, program life over which to spread the non-recurring costs, and advance funding played a very important part in the dual sourcing. All together these criteria determine if dual sourcing will or will not occur and when it will occur.

Investigative question 3 - Because of the current emphasis on competition and dual sourcing in the acquisition environment, how is the ultimate dual sourcing decision in the best interest of the government?

The literature review, cases and interviews emphasize the same advantages for entering into a dual sourcing arrangement. The literature review cites the following general reasons to dual source.

a) cost savings
b) maintenance/improvement of industrial mobilization base
c) improve product performance and quality
d) meeting delivery schedule

All of these reasons were mentioned in the other two data sources, but in a different order. Table 13 lists by case or interview the reasons dual sourcing was attempted. Depending on the specific program situation the most advantageous reasons to dual source vary. For example, the cruise missile industrial base provided by Williams Research Corporation (WRC) was not sufficient to meet the mission needs for the cruise missile engine. The Joint Cruise Missile Program Office decided to dual source to ensure sufficient production capacity was available to meet mission needs and also to elicit a more cooperative response from WRC, but the acquisition strategy also promises to control/reduce costs. The Alternate Fighter Engine (AFE) program started because of reliability and durability problems. The IR Maverick missile and replenishment spare issue both seek to reduce program acquisition costs. Yes, the dual sourcing decisions in this research (Table 13) are in the best interest of the government given the individual circumstances.

TABLE 13

REASON FOR DUAL SOURCING

CASE/INTERVIEW	REASON FOR DUAL SOURCING ACTION
1. GAU-8/A Ammunition	- improved and expanded industrial base - meet schedule demands - lower price
2. Cruise Missile Engine	- expanded industrial capacity - control/reduce cost - reduce schedule risk
3. Alternate Fighter Engine	- need for a better product - reduced life cycle cost - expanded industrial base
4. Mr. Cockeran and Mr. Allen Miller	- save money - insure schedule delivery
5. Mr. Perry ACES	- lower unit cost - expanded industrial base
6. Major Munoz IR Maverick Missile	- reduce price - maintain two production sources
7. Ms. Louis and Mr. Adams SRAM II	- industrial base expansion - price reduction - meeting schedule milestones
8. Mr. Lawson Replenishment Spares	- reduce life cycle cost

Investigative question 4 - What were the expected results of past dual sourcing decisions?

The expected results of past decisions are not different from the expected results of current decisions to dual source. It appears cost savings play a larger role in today's decisions than in the past. Dual sourcing has always been seen as a means to a) reduce costs, b) maintain/improve the industrial base, c) improve product performance and quality and d) reduce schedule risk. This research effort contains data on only one mature dual sourcing action - the GAU-8/A ammunition buy. It was initiated to expand the industrial base to meet present and future production needs and to establish effective competition reducing the price of future ammunitions buys. All expected results or reasons for dual sourcing are contained in Table 13.

Investigative question 5 - Were these expectations met?

Only the GAU-8/A ammunition program is mature enough data to verify attainment of the program goals. In this case, both expected results occurred - an improved and expanded industrial capacity and an average 75% reduction in price.

Investigative question 6 - Is the dual sourcing decision so dependent upon the product in question that a common decision rule for all major weapon systems becomes impractical?

The literature review identifies and discusses criteria impacting dual sourcing in Table two of chapter three. Many of these factors are subjective and vary with weapon type and program. For example, technological risk assessment requires the program office to quantify or measure risk in producing an item that often has never been produced in total or part. It is a judgment call, one rule for all weapon systems just would not work.

The cases and interviews overall supported that decision formalization across a broad range of weapon systems was not possible. The analysis of such factors as production numbers and available funding could be quantified to a degree. Early competition planning requires the program office to make assumptions about out year congressional funding and FSD or production funding for dual sources. These decisions require pragmatic assumptions based on the overall government/contractor (market) situation. The decision to dual source or not also depends on savings to the government. The replenishment spare issue even used a 10% return on investment as a cut off point. The projection of savings is dependent upon the number of units purchased in the out years of production and the estimated sole source costs at that time. Both are pure estimates. Who knows the sole source cost of producing "widget A" 5 years hence when "widget A" has never been produced? Who can predict the favor or disfavor of a

particular weapon system in Congress five years hence? It is in the out years of production that dual sourcing pays off for the government. Decision makers are making dual source decisions based on an assumption which may be very hard to support. As several of the people interviewed stated, funding changes, programs change and the program you plan for is not always the program you buy.

Investigative question 7 - What influence has dual sourcing had on enhancing competition?

All of the people interviewed felt dual sourcing had a positive effect on competition. The many dual sourcing efforts in ASD/AE have resulted in an ASD/AE competitive procurement award rate of 80% versus 35.1% for ASD as a whole. Mr. Perry felt the extra work produced a better product at a lower cost. Mr. Lawson saw dual sourcing as an effective (when appropriate) means to reduce the life-cycle cost of jet engines.

Congressional impetus to compete military procurements was seen as a positive influence. From this, the Air Force Competition Advocate has issued a standardized guide for economically assessing the dual source potential in new programs (Appendix B). This policy guidance forces program offices to determine early in the program's life if and when dual sourcing is to occur and begin planning. It is too

early to measure the effects of CICA and resultant DOD policy, but planning for competition has definitely benefitted.

Conclusion

The method outlines in chapter three has yielded a significant quantity of data supporting the seven investigative questions. General agreement of the data supports the following premise -- the dual sourcing decision is often supported by subjective estimates and assumptions. These estimates and assumptions of key dual sourcing criteria are a large part of the data base, with which the decision maker has to work.

The program office must evaluate technical risk and producibility risk on "state-of-the-art" weapons. They must also evaluate second sources, and assess their capability to do the job. Significant funding is often needed to quality this second source. The program offices must estimate this up front cost plus the cost per unit five or more years hence. Savings resulting from dual sourcing must be documented in order to dual source in today's environment. These savings are based on estimated sole source costs for "state-of-the-are" weaponry, again another assumption. The basis of firmly quoted costs and savings attributable to dual sourcing is saturated with assumptions and estimates of numerous criteria.

Chapter five will take the detailed findings in this chapter and propose conclusions and recommendations. From these, new dual sourcing criteria will be proposed.

V. Summary, Conclusions, and Recommendations

Introduction

This research has provided supporting data for optional dual sourcing decision criteria for use in the Aeronautical Systems Division, Air Force Systems Command. This chapter summarizes the research problem statement, objective and methodology. Following the summary, conclusions are drawn from the findings in chapter four. Based on these conclusions, optional dual sourcing criteria will be proposed. This chapter closes with recommendations for further study.

Summary of Research

Dual sourcing at various phases of the acquisition life cycle has long been a recognized method of enhancing competition in DOD acquisitions. But, past dual source decisions have inconsistently achieved their desired goals. Despite this, the Competition in Contracting Act (CICA) demands weapon systems project managers have "full and open" competition or have a waiver. To meet this requirement demands improved decision criteria identifying those acquisitions best suited for dual sourcing and the most appropriate method. Those decision criteria which best support the desired long term results of a dual sourcing decision are the basis for improved, competitive procurement decisions.

Research Objective

This research evaluated current dual sourcing criteria documented in dual sourcing literature and policy directives,

the criteria on which three past dual sourcing decisions were made (GAU-8/A ammunition, Alternate Fighter Engine, and cruise missile engine) and interviews with ASD policy makers/contracting officers. The resultant data from the three sources was rearranged into more meaningful groupings to facilitate interpretation of results. The data was then edited to insure its accuracy. Following the editing, data was grouped into seven data categories. These categories were 1) Reason for dual sourcing a weapon system, 2) Criteria used in the dual sourcing decision, 3) Competition decision process, 4) Expected results of past decisions, 5) Results of dual sourcing decisions, 6) Extent of decision formalization, and 7) Weapon system characteristics inhibiting/enhancing the formalization of the decision process. These seven data categories were generated for each data source (excluding the literature review). The final step in the analysis compared and contrasted these groups across the data sources to form the information base answering the seven investigative questions. From these seven investigative questions comes the identification of improved dual sourcing criteria.

Conclusions

Based on the findings in chapter four, six primary conclusions are reached. These conclusions are listed below and are followed by a brief explanation.

1. Competition strategy planning begins early in the acquisition life of a weapon system.

Every case and interview analyzed demonstrated early competition planning. The very latest introduction of competition planning was prior to Full-Scale Development. Normally, a program acquisition strategy was developed soon after program start up.

2. Every attempt is made to thoroughly consider competition and all its possibilities from the beginning of a weapon systems development.

The Business Strategy Panel meeting at ASD reviews the economic, technical and program analysis done by the program office. The Business Strategy Panel also reviews Request for Proposals and source selection criteria proposed by the program office.

The competition advocate's office consults closely with the program office before, in and after, the Business Strategy Panel meeting concerning competition of the current buy and follow-on buys. If appropriate circumstances exist, dual sourcing is advocated.

The Air Force Competition Advocate Office has recently issued explicit economic guidance on dual sourcing potential weapon systems and their components. Air Force competition policy requires a competition review of any new weapor program or follow-on purchase of a current sole source procurement.

3. The general reasons for establishing a second source to enhance competition have not changed.

The general reasons to pursue dual sourcing most often

cited in the literature parallel those frequently cited in the case studies and interviews. There is not and never was one single reason to dual source. The fundamental reasons in chapter two still apply today. They are:

a) cost savings

b) maintenance/improvement of industrial mobilization base

c) improve product performance and quality

d) meeting delivery schedules

4. Environmental factors outside the control of the program office make accurate competition (dual sourcing) decisions difficult.

Variable funding from year to year makes early dual sourcing decisions difficult. Dual sourcing requires early planning and up front funding to qualify the second source. No one can guess funding level five and six years into a program. Politics change and programs change appropriately. A major change in a program could invalidate all the assumptions on which the up front planning was based or delete necessary funding. Formalization on the decision process can not reasonably account for these changes.

5. There is general agreement on the core dual source decision criteria.

All three data sources agree on the core decision criteria in dual sourcing. These three criteria are funding, quantity to be purchased (overall and yearly), and schedule or length of the acquisition. Beyond these three criteria,

each program investigated chose to emphasize a variety of decision criteria.

6. A majority of the personnel interviewed noted the difficulty in estimating the true savings of dual sourcing.

The savings generated by a dual sourcing action take the life of a program to realize. Estimating these savings requires the comparison of dual source start up costs and eventual purchase price. Predicting exact figures or knowing the exact number of units to be purchased is practically nil. As one interviewee stated, if a dual sourcing action can not demonstrate a savings to the government, it probably will not be attempted. Having an accurate estimate of potential savings directly impacts the dual sourcing decision.

Recommended Criteria for Implementation

Dual sourcing criteria are well documented and have not changed. The major issues or criteria (chapter two) include those decision criteria recorded in chapter four. The issues covered by the three prong analysis used in ASD compare quite closely to Table two (chapter two).

A closer examination of the findings discloses a weakness in the criteria, not in deciding to dual source or how, but in the generation of concrete supportable estimates of the decision criteria. The attainment of better estimates is a function of time and realistic funding levels. As data banks on specific weapon systems grow, patterns will develop and those decision criteria most significantly re-

flecting positive dual sourcing outcomes will appear. As this historical pattern emerges, so will standard decision criteria which best model that weapon system. For example, examine the dual sourcing philosophy used in aircraft missiles. Three criteria present in both the ALCM and SRAM II are a high degree of subcontractor work and need for a large number of units over a relatively long period of time. Based partially on these criteria, the dual sourcing of major subcomponents is practiced in both acquisitions. As the dual sourcing strategy is repeated, relationships between cost and criteria develop which can be reliably transferred to new aircraft missile programs. Given congressional interest in competition, dual sourcing should increase. Knowing the level of program financing in future years impacts significantly the estimate of projected savings. As stated in the conclusions, a dual sourcing action which can not show a savings probably will not be attempted. Viewed from another prospective, suppose a program is deemed sufficiently funded during the production phase (high number of units) to support a leader-follower dual sourcing. Just prior to commencement of production, out year funding is cut by one-half. Will the program office buy the weapon system at a lower than sole source cost? Probably not, the dual sourcing action incurred a large financial investment by the government which was to be applied over twice the actual production number and twice the yearly production rate. The originally projected

savings will decrease or disappear. A realistic assessment of funding levels at the beginning of the program could have initiated some of the problems. Given congressional history, assume program buys will be cut and/or stretched out. History of similar past weapon procurements can give the program manager a guide to potential funding cuts in future years. More concrete estimates of decision criteria supporting the dual source decision process will yield a better decision and result in a more efficient use of DOD procurement dollars.

Once a second source has been selected and it has been qualified to begin production, how is competition maintained for the good of the Air Force and both producers? The current decision criteria do not adequately address this concern. Three programs in this study dealt with the split award. The GAU-8/A ammunition case developed a unique method based on price. The alternate fighter engine acquisition determined the split based on competition promotion clauses in each proposal. The IR Maverick missile split was an adaptation of another specialized method. This method looked at price and management factors. Given the assumption that both producers are qualified; i.e., produce a quality product and can deliver to schedule, then the program office has true price competition. To maintain this competition in future years, the decision makers need to evaluate the stability of both companies and temper any computer generated split with this company assessment. An

equation blindly followed could give what appears to be a sufficient production buy to the high cost company but, that company may be experiencing financial or other problems which when combined with a low production buy could cause them to cease production. Then, all the up front government funding and management effort is lost and a sole source again exists. When a computer program with weighted criteria is used to establish the split ratio between two producers, include the criteria -- producer stability. This criteria would include management competence, percent of work performed for the government, current financial situation, government investment, the government's desire to continue price competition, and the desire to maintain the company's presence in that particular portion of the defense industrial base. As stated in all the interviews, dual sourcing returns cost saving benefits in the out years of the acquisition program. It is to the government's advantage to keep both producers qualified throughout the life of a weapons program or until the decision is made to execute a "buy-out" competition. A split production buy likely to remove one of the production sources may gain the government a temporary price advantage but, the greater long term gains of dual sourcing are lost.

Recommendations for Future Study

The programs referenced in this research effort should be studied in depth after their completion or at least fol-

lowing a reasonable production run. Then, the assumptions made five and six years previous can be adequately judged. These correct decisions can then form a data base from which improved decisions can be based in the future. These same programs should be compared with respect to the cost of the originally planned program at FSD versus the actual program execution. The true cost of the yearly funding cycle process would then be known.

Future study into split methodology needs to examine the several methods which exist in the literature today and how they account for the many subjective estimates of criteria required by program managers. Do these methodologies, in practice, produce results which insure the continued existance of both production sources?

Concluding Remarks

Competition is a permanent component of the DOD acquisition process. How it is planned for and carried out will determine the effectiveness with which we spend the DOD acquisition dollars. In order to do this, program managers need better estimates of those decision criteria impacting competition in their programs. Once implemented, competition needs to be sustained until its logical conclusion. The task is a difficult one, but program managers possess the criteria necessary to effectuate competition. As more programs promote competition in the individual phases of the acquisition cycle, lessons will be learned and better dual sourcing decisions will be made.

Currently, CICA and the implementing directives provide a good policy structure on which to base competition and multiple sourcing decisions. Thoughtful application of the structure will produce more precise dual source decision criteria, new criteria, and ultimately, more consistent, quality dual source decisions.

Appendix A: Interview Guide

1. Is a logical decision process followed during planning for production competition of a major weapon system and/or major components? If not, how is competition addressed?
2. If so, how early in the planning phases of the acquisition cycle does competition planning begin?
3. What decision criteria are used during source selection to evaluate proposals and their potential for dual sourcing from the onset of production or future dual sourcing?
4. How does the dual source decision process fit into the entire source selection process?
5. Which criteria carry the greatest weight in the final decision to dual source?
6. In typical dual sourcing decisions, when is the second source introduced?
7. Is there intense pressure in the acquisition community to compete via dual sourcing at all costs?
8. When the decision to dual source is made, what is the predominate reason more often pursued?
9. Does the reason vary with the weapon system and existing market conditions?
10. What degree of confidence or certainty have past dual sourcing decisions been made?
11. Were they good decisions?
12. Are current dual sourcing decisions made with any

greater degree of confidence that expectations (goals) will be met?

13. What has caused the increase (decrease) in decision confidence levels?
14. What decision criteria or factors continue to prevent more effective dual source decisions?
15. What major characteristics of the proposed weapon system and its components enhance/inhibit the use of standard decision criteria?
16. Is a formalized decision process realistic?
17. How has dual sourcing impacted competition?

Appendix B: Guidelines for Determining the Use of Competitive Multiple Sources

Currently, the laws and regulations which prescribe the acquisition of weapon systems mandate the use of competition in the solicitation and award of Government contracts. However, certain exceptions to the use of competition are recognized and may be pursued when justified.

The use of multiple sourcing, i.e., maintaining more than one source during development and/or production for the purpose of sustaining competition, is receiving increased emphasis. In order to facilitate our ability to accurately and objectively assess how, when, and if multiple sourcing should be pursued, we have developed these guidelines for use by program managers as the basis for justifying the most effective competitive strategy to be pursued. Application of the guidelines results in a report that summarizes the multiple source strategies considered and the acquisition strategy finally selected by the program manager. The format for the report is intended to instill a structured analysis methodology and discipline. The depth and breadth of the analysis will depend upon the nature of the program being evaluated.

1. The Multiple Source Analysis Report

   a. The analysis should be written in sufficient detail to:

      (1) Provide confidence to management that the decision multiple sources will be feasible and cost effective;

(2) Assess which multiple source strategy will provide the greatest return for the least amount of acceptable risk;

(3) Provide an estimate of the investment funds needed to develop multiple sources; and

(4) Provide clear and convincing evidence when multiple sourcing is not in the best interest of the government.

b. All cost estimates should be in consistant dollars and should be based on life cycle costs.

c. Selecting the Best Production Multiple Source Strategy.

(1) When starting a production multiple source analysis, the program manager has several competitive strategies to choose from. The problem is which strategy should initially be pursued. A preliminary screening technique is provided by the Defense System Management College (DSMC) Handbook "Establishing Competitive Production Sources. This screen is a checklist which will guide the program manager to those multiple source strategies that best fit the program under consideration. The detailed multiple source analysis should be done on that strategy indicated by the preliminary screening. If that multiple source strategy results in positive returns and is the multiple source strategy to be pursued, then no additional analysis will be required. If that multiple source strategy results in negative returns, then other multiple source strategies should be analyzed.

(2) If the detailed analysis demonstrates that no multiple source strategy is practicable for FSD and/or production, then the analysis must set forth the reasons with sup-

porting documentation.

d. The format for reporting the analysis of multiple sourcing alternatives has been structured to provide uniformity in analysis. The format is divided into four main segments: Program/System Description, Full Scale Development, Production, and Baseline Assumptions for the selected strategy.

(1) Program/System Description. A brief description of the program/system is required. The description should include the history of the system and its intended use. Describe in general terms the significant aspects of FSD and production and when, it ever, a buyout is contemplated.

(2) FSD. A detailed discussion of the multiple source competitive strategy that will be used during FSD is required along with an estimate of the benefits to be achieved. Include the different types of competitive strategies that are examined and the results of that examination. If the strategy will not be multiple source competitive, then explain why using ong or more of the following:

(a) Multiple sourcing would not materially reduce the technological risks of the program;

(b) Multiple sourcing would not likely result in an improvement in design commensurate with the additional cost;

(c) Multiple sourcing would result in unacceptable delays in fulfilling the needs of DOD;

(d) Multiple sourcing would be adverse to naitonal security interests.

If the strategy is based on cost, the rationale for cost estimates must be provided. In most cases, the discussion will be based on risk reduction and/or quality improvement resulting from parallel development.

(3) Production

(a) A detailed discussion of the multiple source strategy to be pursued during production must be provided. The sole source strategy and any other multiple source strategies examined must also be discussed. The narrative will include an assessment of the risk of each strategy to the program, including sole source. If the strategy will not be multiple source competitive, then explain why using one or more of the following:

(i) Multiple sourcing would increase the total cost for the program;

(ii) Multiple sourcing would result in unacceptable delays in fulfilling the needs of DOD;

(iii) Multiple sourcing would be adverse to national security interests.

(b) A summary of the sole source and competitive strategies examined must be provided in accordance with Exhibit A "Summary of Production Multiple Source Strategies." This Exhibit is to be supported by Exhibit B "Sole Source Recurring Cost Estimates," Exhibit C "Multiple Source Recurring Cost Estimate," and Exhibit D "Comparison of Sole Source and Multiple Source Estimates." Each Exhibit is provided with a set of instructions and each exhibit will be

supported by detailed discussions of the cost elements used to derive the estimates. Each competitive strategy will have a separate Exhibit C and D, and each strategy (including sole source) will have a milestone chart of program events.

(c) The net savings in column (7) of Exhibit D will be discounted at the rate directed by OMB Circular A-94. As of Apr 86, the directed rate is 10 percent. For those competitive strategies that have a positive net present value, an internal rate of return calculation is required. If none of the production multiple source strategies have a positive net present value, then a break-even analysis should be provided. This break-even analysis should state what conditions or assumptions must be used in order for a multiple source strategy to break even at the directed discount rate.

(4) Baseline Assumptions for the Selected Strategy. It is important when commitments to long term strategies are made that the fundamental assumptions underlying the selected strategy are clearly set forth so that all interested parties are aware of the ground rules. If the ground rules change, then a change in the selected strategy may be warranted. Therefore, this section of the analysis provides the opportunity to lay out the baseline assumptions for the selected strategy along with the source of those assumptions:

(a) Funding

(b) Quantity (total and annual rate)

(c) Schedule

(d) Other

2. Special Issues

a. Timeliness and Type of Data.

(1) Because the available amount of empirical data may be limited or only budgetary, the estimate of the effects of competition on learning curves, prices, etc., is subjective. All this places high cost risk on the analysis.

(2) To counter this problem, the multiple source analysis should be updated at least once before the FSD and the production procurements are undertaken to assure that the assumptions and estimates are still valid. This will ensure that an improper sole source strategy, which may have been appropriate five years ago, is not pursued. Conversely, a program which may have shown a positive return five years ago, may now indicate that a multiple sourcing should not be pursued.

b. Quantity Split During Competition.

Several factors need to be considered when deciding, for anlysis purposes, the quantity split between two competing sources. If the data is available, consideration should be given to each competitor's capacity, minimum production rate, and tooling requirements; this data will set the bounds for the quantity split. Given the bounds, the optimum split for the analysis can then be determined by varying the quantity splits until the minimum total cost is obtained. Any quantity split that would have a major effect on production rate must take into consideration that effect on the learning/price curve and the estimate of nonrecurring tooling costs. In an

actual competition the quantity split would be determined by the proposed prices (and other factors) and would not be dictated by any optimum split done in a paper study.

3. Formulas Used on Second Source Analysis

a. Recurring Production Cost.

The formula used to calculate the recurring lot costs for the sole source and competitive estimates is:

$$\text{Total Lot Cost} = \frac{T1}{(b+1)} \times [K^{(b+1)} - J^{(b+1)}] \text{ where } b = \ln(\text{slope})/\ln(2)$$

T1 = Unit one price

b = The exponent for the learning/price curve

K = Cumulative quantity through lot (N)

J = Cumulative quantity through the preceding lot (N-1)

ln = Natural logorithm

slope = slope of the learning/price curve, expressed as a decimal

b. Net Present Value and Internal Rate of Return.

(1) The formula for the net present value and internal rate of return is:

$$NPV = \sum_{t=1}^{K} [(NS)_t/(1+DR)^t)]$$

NPV = Net present value $\quad \sum$ = Summation

$(NS)_t$ = Net savings per year t

DR = Discount rate

t = Year

k = Number of Years (Time period multiple sources will be maintained)

(2) When calculating the net present value, the discount rate is equal to .1 (10 percent). When calculating the internal rate of return, NPV is equal to zero and the discount rate is the unknown.

c. The formulas shown above can easily be programmed into a personal computer using spreadsheet software such as LOTUS.

d. The Defense System Management College (DSMC) has developed a user-friendly computer model based on its handbook "Establishing Competitive Second Sources." The DSMC model will be more flexible and easier to use than the above formulas and be substituted.

Preliminary Screening Matrix

(Source: DSMC Handbook, "Establishing Competitive Production Sources," Aug 84, page 3-9)

Decision Variable	PRODUCTION COMPETITION METHOD: Form Fit Function	Technical Data Package	Licensing	Leader-Follower	Contractor Teaming
ECONOMIC					
Quantity					
High	+	+	+	+	+
Medium	+	+	0	0	+
Low	0	0	-	-	0
Duration					
Long	+	+	+	+	+
Medium	+	+	0	+	+
Short	0	0	x	x	0
Tooling Cost					
High	-	-	-	-	x
Low	+	+	+	+	+
Progress Curve					
Steep	-	-	-	0	0
Flat	+	+	+	+	+
Contractor Capacity					
Excess	-	-	-	-	-
Deficient	+	+	+	+	+
TECHNICAL					
Complexity					
High	0	x	+	+	*
Medium	+	-	+	+	+
Low	+	+	+	+	+
State-of-the-art					
Pushing	0	x	+	+	*
Within	+	+	+	+	+
Other applications					
Yes	+	0	+	0	+
No	+	+	+	+	+
Private R&D					
High	0	x	0	x	-
Low	+	0	+	+	+
PROGRAM					
Maintenance Requirements					
Complex	x	0	0	0	0
Nominal	+	+	+	+	+
Production Lead times					
Long	-	-	-	-	-
Short	+	+	+	+	+
Degree of Subcontracting					
Heavy	0	-	-	-	-
Light	+	+	+	+	+
Contract Complexity					
Complex	-	-	-	-	-
Simple	+	+	+	+	+

Exhibit A Instructions

1. The following instructions/notes are applicable to the required Exhibit A:

a. Column (1), Strategy Description: Provide the sole source strategy and the names of the types of multiple source strategies examined.

b. Column (2), Recurring Cost: Enter the total recurring cost estimated for the sole source strategy and each source strategy examined.

c. Column (3), Additional Non-Recurring Cost: Enter for each multiple source strategy the total non-recurring cost added to the program for the establishment and maintenance of a second source.

d. Column (4), Net Savings from Competition; Undiscounted: Enter the total net savings for each multiple source strategy.

e. Column (5), Net Savings from Competition; Discounted at 10%: Enter the Net Present Value (NPV) of the total net savings for each multiple source strategy.

f. Column (6), Internal Rate of Return (IRR): Enter the IRR for each multiple source strategy examined.

g. Column (7), Risk: Provide an assessment of the integrated risk (low, medium, high) for the program under the sole source strategy and an assessment of the risk added to or reduced from the program for each multiple source strategy examined.

EXHIBIT A

SUMMARY OF PRODUCTION MULTIPLE SOURCE STRATEGIES

(CONSTANT FY DOLLARS)

PROGRAM NAME (SYSTEM OR SUBSYSTEM)

(1) Strategy Description	(2) Recurring Cost	(3) Additional Non-Recurring	(4) Net Savings from Competition Undiscounted	(5) Discounted (10%)	(6) IRR	(7) RISK
Sole Source	From Exhibit B	N/A	N/A	N/A	N/A	
Multiple Source Strategy 1	From Exhibit D Column (4)	From Exhibit D Column (6)	From Exhibit D Column (7)	From Exhibit D Row (8)	From Exhibit D Row (9)	
Multiple Source Strategy 2	"	"	"	"	"	
Multiple Source Strategy 3	"	"	"	"	"	

N/A = Not Applicable

Exhibit B Instructions

1. The following instructions/notes are applicable to the required Exhibit B.

a. Column (1), Lot Number: Identify each production lot, numbered sequentially.

b. Column (2), FY Buy: Identify the corresponding fiscal year for each production lot.

c. Column (3), Quantity: Enter the quantity to be produced for each lot and the total quantity for the production program.

d. Column (4), Recurring Cost: Enter the recurring cost estimate for the lot quantities and the total recurring cost for the sole source production strategy. On a separate sheet provide a narrative quantitative rationale for the derivation of the recurring cost estimate.

EXHIBIT B

Sole Source Recurring Cost Estimate

(Constant FY Dollars)

Program Name (System or Subsystem)

(1) Lot Number	(2) FY Buy	(3) Quantity	(4) Recurring Cost
		TOTAL QUANTITY	TOTAL COST

Exhibit C Instructions

1. The following instructions/notes are applicable to the required Exhibit C.

a. Column (1) and (2): Self Explanatory

b. Column (3), First Source Quantity: Enter the lot quantity to be produced by the first source (or incumbent) and the total quantity for the first source. On a separate sheet describe how the quantity split was derived before and after competition.

c. Column (4), First Source Cost: Enter the recurring cost for the lot quantities to be produced by the first source and the total recurring cost for the first source. On a separate sheet describe how the estimates were derived before and after competition, noting price curves used, and shift and rotation.

d. Column (5), Second Source Quantity: Enter the lot quantity to be produced by the second source and the total quantity for the second source. Note that the total quantity for the first source when added to the total quantity for the second source should equal the total quantity for the sole source strategy unless a reduction in units is being used to finance the sole source. The required supporting rationale is similar to paragraph 1b. above.

e. Column (6), Second Source Cost: Enter the recurring cost for the lot quantities to be produced by the second source and the total recurring cost for the second source.

Supporting rationale for these estimates is required as in paragraph 1c. above.

f. Column (7), Multiple Source Cost: This column is the sum of columns (4) and (6).

EXHIBIT C

MULTIPLE SOURCE RECURRING COST ESTIMATE

(CONSTANT FY DOLLARS)

PROGRAM NAME (SYSTEM OR SUBSYSTEM)

NAME OF MULTIPLE SOURCE STRATEGY

(1)	(2)	(3)	(4)	(5)	(6)	(7)
		First Source		Second Source		
Lot Number	FY Buy	Qty	Cost	Qty	Cost	Multiple Source Cost
		Total Qty	Total Cost	Total Qty	Total Cost	Total Cost

Exhibit D Instructions

1. The following instructions/notes are applicable to the required Exhibit D.

a. Column (1) and (2): Self Explanatory

b. Column (3), Sole Source Recurring Cost: Enter the recurring cost for the lot quantities and the total recurring cost for the sole source strategy as provided in Column (4) of Exhibit B.

c. Column (4), Multiple Source Recurring Cost: Enter the recurring cost for the lot quantities and the total recurring cost for the multiple source strategy as provided in Column (7) of Exhibit C.

d. Column (5), Savings: This column is the subtraction of the costs in Column (4) from the costs in Column (3).

e. Column (6), Additional Non-recurring: Enter the nonrecurring costs that are added to the program for the establishment and maintenance of a second source. On a separate page provide detailed supporting rationale for the nonrecurring estimate.

f. Column (7), Net Savings: This column is the subtraction of the additional nonrecurring cost in Column (6) from the savings in Column (5).

g. Row (8), Net Present Value (NPV) of Net Savings at 10%: Enter the NPV, discounted at 10%, of the net savings in Column (7).

h. Row (9), Internal Rate of Return (IRR) of Net

Exhibit D Instructions cont.

Savings: Enter the IRR of the net savings in Column (7).

EXHIBIT D

COMPARISON OF SOLE SOURCE AND MULTIPLE SOURCE ESTIMATES

(CONSTANT FY __ DOLLARS)

PROGRAM NAME (SYSTEM OR SUBSYSTEM)

NAME OF MULTIPLE SOURCE STRATEGY

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lot Number	FY Buy	Sole Source Recurring Cost	Multiple Source Recurring Cost	Savings	Additional Nonrecurring	Net Savings
		Total Sole Source Cost	Total Multiple Source Cost	Total Savings	Total Additional Nonrecurring	Total Net Savings

NPV of Net Savings at 10% (8)

IRR of Net Savings (9)

The following symbols are used to indicate which economic, technical and program variables are better (or worse) suited for a particular multiple source strategy:

* * for a particularly preferred method
* + for strong effectiveness
* O for neutral
* - for weak effectiveness
* x for a particularly inapproporate method

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Dual sourcing is a recognized method of inducing competition into the Department of Defense acquisitions. The environment in which DOD acquisition occurs has changed dramatically in the past five years. Both the executive and legislative branches of government have initiated various programs and laws all proposing to improve the acquisition process. The latest aid comes from Congress via the Competition in Contracting Act of 1984. This act philosophically changed the emphasis of DOD acquisition from the method of contracting to the market condition of "full and open" competition and its promotion and sustainment. This new emphasis has increased the interest in dual sourcing amongst program managers. When past dual sourcing actions are studied, the results do not consistently produce reduced costs and strengthened industrial base. Knowing what criteria best measure dual sourcing's potential to enhance competition allows DOD program managers to more effectively utilize limited resources. This research looked at current literature findings on dual sourcing criteria. These findings were then compared to three case studies and the findings from five interviews. The interviews involved Aeronautical Systems Division program offices currently involved in dual sourcing actions. The research objective was to evaluate the dual sourcing criteria from these three sources and propose optional dual sourcing criteria improving the dual sourcing decision. Six conclusions were reached with this methodology. From these conclusions two recommendations were made. It was found that the basic criteria in the literature are still valid but many of the criteria are subjective. As such, it is difficult to generate concrete supportable estimates. Secondly, an additional criteria - producer stability was suggested for inclusion in the decision process to split a contract award between two producers.